REHABILITATION OF THE WAR INJURED

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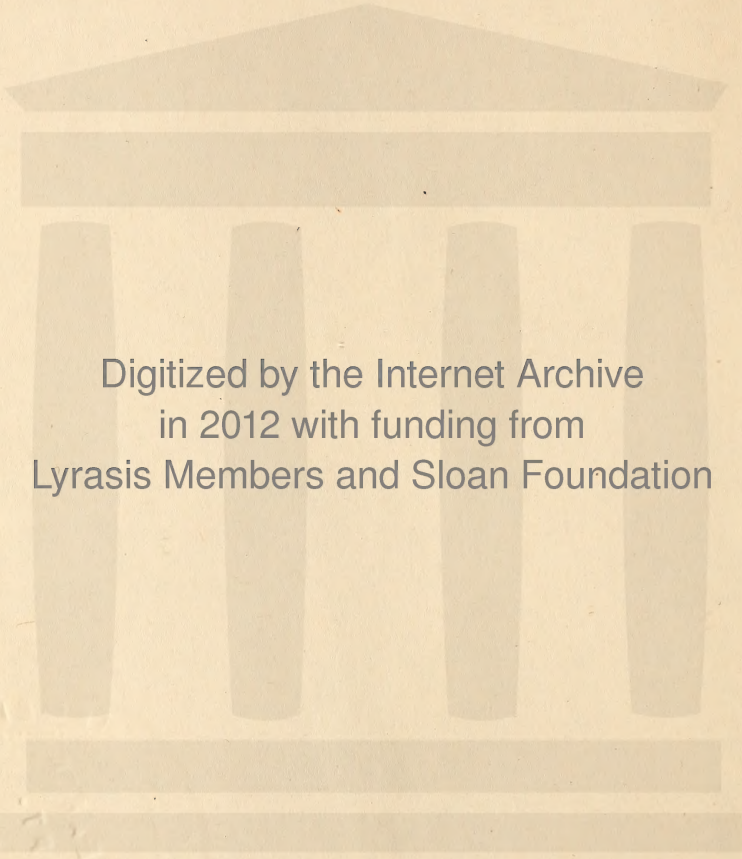

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REHABILITATION
of the
WAR INJURED

A SYMPOSIUM

Edited by

WILLIAM BROWN DOHERTY, M.D.

AND

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treatment of prolonged sequelae of head injury, although other types of neurologic disturbance also claimed attention. The surgical aspects of acute injuries have been commented on elsewhere.[1, 2] From the beginning, it was evident that, as had been foreseen, the proper treatment of the late effects of head injury under service conditions required a more than usually thorough preliminary examination. The large numbers of possible factors causing failure to return to duty following a reasonable convalescence from head injury (six weeks was the arbitrary time adopted) may be resolved into two chief categories — organic and psychoneurotic. It is essential to assess these factors accurately, for their treatment and disposal differ greatly.

The Registry has already collected complete data, including follow-up, on well over 1200 cases of head injury handled by the hospital. Complete analysis will ultimately be published by the British Medical Research Council, which finances this aspect of the work. The kind of problem involved can be estimated from my personal notes of the last 400 cases of persistent disability admitted by me for assessment. It must be emphasized that, although the hospital received acute head injuries from a large area and a majority of cases of persistent disability from all areas, these figures are highly selective, and complete data regarding all head injuries or all casualties cannot be published at present. I purposely omit the patients with recent injuries who made rapid recoveries. Out of the 400 cases of unduly delayed convalescence, 38 patients had suffered gunshot wounds of the head, 13 injuries to the head in aircraft crashes, 303 head injuries from other trauma (motorcycle or other accidents with vehicles, tanks and so forth), and 46 from recurrence of symptoms from old head injury dating from before the war. Of these 400 men, 22 (5.5 per cent) were suffering from *traumatic epilepsy,* 116 (29.0 per cent) from other *organic defects,* and 262 (65.5 per cent) solely or chiefly from *psychoneurosis.* In the group of 38 gunshot wounds, 3 patients suffered from epilepsy, 19 were still disabled by organic (structural) disorders, and 16 by psychoneurosis. Of these, 21 were subsequently fit to return to duty, and

17 were discharged unfit. The proportion of the 400 returned to duty was almost exactly the same.*

It is clear that disorders such as hemiplegia and aphasia following a laceration of the brain are the result of damage to structure; on the other hand, a prolonged disability, such as insomnia, tremors, depression and fear of crowds, following a trivial head injury in a person who was previously prone to such symptoms is palpably psychoneurotic. The actual decision is, however, seldom so clear cut, and with increasing experience of all classes of injury from a variety of circumstances, more and more involved mixtures of organic and functional sequelae were defined by modern methods. Thus, to quote extremes, the aircraft pilot who has made a perfect recovery from a surgical head wound, has shown himself fit for every form of strenuous physical exertion, and pesters everyone to be allowed back to duty may develop a serious flying error on return to his squadron owing to a previously undisclosed nervous anxiety caused by the terrifying circumstances of his accident. Apart from the danger of further accident, treatment for this neurosis involves a waste of time that is saved if the liability is diagnosed earlier. The patient who has suffered an aparently trivial head injury and later wanders, with loss of memory, is sometimes shown by the electro-encephalogram or subsequent attacks to be suffering from epilepsy, although his original wandering fugue was hysterical and his memory is recoverable under Amytal. The patient behaving in a clearly neurotic manner may be found to have a xanthochromic spinal fluid, and the real reason for the failure to return to efficient duty of a patient with optic atrophy in one eye may be related not to his vision but to his anxieties about his relatives at home. An unsuspected abscess may be discovered by a chance air encephalogram, and an unsuspected but fundamentally important emotional factor may slip out in a casual remark.

Moreover, in the modern soldier, the tremendous tension of modern warfare — the noise, the rush of movement, the variations

* Symonds has published in the July, 1942, issue of the *Proceedings of the Royal Society of Medicine* the results of a follow-up of 871 cases, including the 400 mentioned here, that show 68 per cent successful return to service duties.

lepsy occurring within the first four weeks after injury has an excellent prognosis — was fully borne out in our cases. The electroencephalogram shows widespread activity of epileptic type in many cases of laceration of the brain without clinical evidence of convulsions (Williams[11]), and this also rapidly subsides without aftereffect. There is, however, an exceptional and rare type of case in which a relatively trivial injury has been followed by persistent severe fits of a generalized kind, with an electrical record in the intervals between the attacks resembling that of deteriorated idiopathic epileptics. A previous constitutional liability to epilepsy is then to be suspected, and the prognosis is poor.

Other Organic Disabilities.—Of the other consequences of structural damage to the brain, hemiplegia, paraplegia from wounds to the vertex, hemianopia or scotomatous field defects and dysphasic-dyspraxic disorders are obviously serious disabilites. Much can be done to rehabilitate such men for some form of civilian employment, with training in special skills. The same training facilitates the speed of recovery of lesser disorders of motor function, sensation, speech and vision. Persons who are really effective in designing exercises in muscle re-education, or to obtain sensory co-ordination, and who can direct speech therapy and visual exercises are few. Moreover, such treatments are time consuming. The experienced physician therefore early selects cases with a good prognosis for return to duty and retains them in the service hospital, advising early discharge of the remainder to civilian rehabilitation centers. The general nature of the problem is well described by Goldstein[12] in a monograph in which he summarizes his experience in World War I. He gives an excellent description of methods again found useful both in accurate assessment and in rehabilitaion. It is not practicable to rehabilitate all men in a service hospital that has a large waiting list.

In cases requiring bony repair, with fractures into a frontal sinus,[13] with retained foreign bodies, and with jaw, facial, ophthalmic and other injuries, surgical consultations and conferences regarding the main disability are indicated; if necessary, the patient

is transferred to a surgical division, to return later for the neurologist's supervision during final convalescence. In some cases of recent injury (and usually in hitherto unsuspected scalp wounds), a subdural hematoma, an abscess or necrosis of the bone requires direct surgical relief.

Post-traumatic General Cerebral Syndrome

Prominent in the sequelae of head injury are headache, usually associated with vertigo, difficulty in concentration and insomnia, with or without depression. This whole group, variously described as the "postconcussion syndrome," "post-traumatic general cerebral syndrome" (Foerster[14]) and "minor contusion syndrome" (Symonds[15]) is by far the commonest symptom complex that develops out of craniocerebral injuries. It follows all kinds and degrees of head injury, although many writers have commented on its absence in many cases of severe laceration of the brain (Russell,[16] Schaller,[17] Strauss and Savitsky[18] and others). A general discussion of the symptoms is given by Symonds.[15] Schaller[17] subdivides cerebral post-traumatic disorders into the "post-traumatic psychoneurotic state," with symptoms of headache, dizziness and hysteria, and the "post-traumatic concussion state (encephalopathy)," with loss of concentration, defective memory and vertigo. This presupposes that headache, dizzines and so forth are psychoneurotic symptoms, and some frankly ascribe the combination to a compensation motive. Others[16, 19] have pointed to its occurrence in cases without compensation factor of any kind. The subject has been very adequately reviewed by Strauss and Savitsky.[18] Penfield and Norcross[20] claim that post-traumatic headache is due to meningeal adhesions demonstrable by their special technic for showing subdural air and that "the patient's description of his symptoms makes the diagnosis certain and allows the understanding physician to recognize the true sufferer." They do not specify the elements in the description on which this sanguine statement is based. It is probable that headaches of organic and psychoneurotic types should have different clinical characteristics. With my associates, I attempted, unsuccessfully, to define such dif-

transient paralysis of nervous function. In head injury, it is generalized, and is produced by sufficiently sudden acceleration or deceleration of the head. It is thus often absent in crushing injuries, even though they cause multiple fractures and other damage,[22] for the head is not then subjected to change in velocity.

It is common knowledge that extradural hemorrhage, subdural hemorrhage or cerebral contusion can be produced by an injury that does not concuss the patient. These effects are due to local tears or distortions. Clinical evidence shows that medullary contusion, with or without subarachnoid hemorrhage, can be produced without concussion.[24] In war surgery, the absence of concussion in penetrating injuries of the brain has been commonly noted (Léri,[25] Denny-Brown,[24] Denny-Brown and Russell[22] and Eden and Turner[26]). Concussion is the outcome of *general commotion* of the brain, which is slighter or absent when penetration occurs, especially with small fragments.

Recently, fat embolism has been held responsible for concussion (de Gutiérrez-Mahoney[27]). This, however, did not occur in my experimental work on concussion.[22, 23] Furthermore, the recognized clinical disorder due to fat embolism is delayed in onset and characterized by unmistakable features in pathology (Osnato and Giliberti[28] and Robb-Smith et al.[29]). In all the cases of acute head injury in this series, there was only 1 patient who clearly suffered from fat embolism — that is, fever, petechiae and fat in the urine. The patchy damage it causes in the cerebral cortex is identical with the patchy cell changes in the cerebral cortex found months or years after injury that are described by Winkelman and Eckel[30] and that are considered by them to be the basis of the post-traumatic general cerebral syndrome.

The common types of severe head injury show various combinations of a series of separate clinical entities, including medullary contusion, subarachnoid hemorrhage, general cerebral concussion, cerebral contusion, laceration, intracerebral and extracerebral hemorrhage, subdural collections of blood or fluid, skull fracture and, sometimes, fat embolism. Each or all may be followed by the syn-

drome in question. Despite the influence of posture, one should regard the syndrome at this stage as a *particular mode of reaction to head injury,* without specific identification with either an organic or a functional basis. In this sense, it is directly comparable to the "effort syndrome," recognized by Wood[31] and others as related to either cardiac disease or cardiac neurosis and, in both, a type of reaction to cardiac symptoms. Only in this way does it appear possible to reconcile the appearance of the post-traumatic syndrome in association with a great variety of types of injury. Some illustrative examples indicate the general nature of the problem.

Case 1. Driver R. L. B., aged 21, was thrown from an army car on January 10, 1940. There was a retrograde amnesia for a few seconds and a blank in memory for 10 minutes after the injury. The patient then vomited and was taken to a hospital. There was a bruise in the right temporal region, but no other injury. Right-sided headache continued for 3 days and then ceased. The patient felt well and was discharged to duty after 3 weeks. In May, after 10 days of continuous fighting, he became very exhausted and once fainted for a few minutes. He came through Dunkirk without incident but a month later began to suffer from generalized headache every 3 or 4 days lasting all day, more pronounced with exertion or excitement, and associated with dizziness on movement. In the next month, he fainted four times, usually after some physical exertion. His mother and a cousin had suffered from psychoneurosis, and his mother had fainted on several

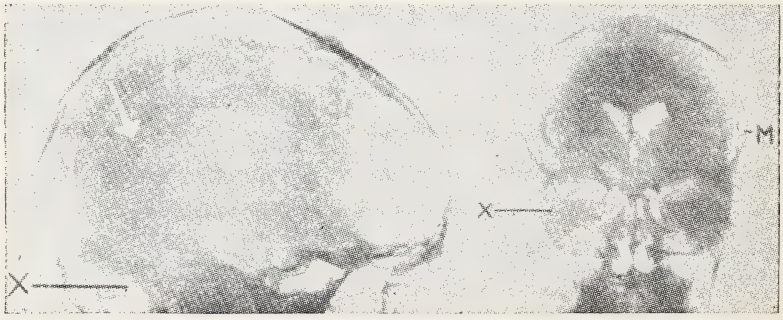

Figure 1. *Case* 2.

In the lateral view of the skull, just below the arrow, is a small puncture of entry of the bomb fragment, with underlying gray flakes of bone and small metal particles. The main metal fragment had crossed the cavity of the skull to lie on the tentorium, where it is seen through the mastoid cells (to the right of the line x). The anteroposterior view, with the ventricles filled with air, shows enlargement of the ventricle on the side of entry and the metal fragments (m and x).

occasions. He had been an average scholar, had always been a worrying, sensitive fellow, and had once fainted at a camp at the age of 12 years.

He was of pale complexion and poor physique, but had no sign of injury to the head and no abnormal physical signs. X-ray films of the skull showed no bony injury. An electroencephalogram was normal. The red-cell count was 4,175,000 with a hemoglobin of 85 per cent. After prolonged interviews, the patient recollected being terrified of traffic after his accident and had vivid recollections of it for some weeks. He explained how he then became less nervous, but after Dunkirk had vivid recollections of the fighting and became terrified of the possibility of pain or the sight of blood. He said, "I could not go through that again." He developed fears of traffic or air raids, and had nightmares of falling and of being wounded. He was sure that he had fractured his skull and damaged his brain.

He responded immediately to psychotherapy but relapsed, with further headache and complaint of dizziness at the prospect of return to duty, and was eventually discharged as permanently unfit.

This patient presented the post-traumatic syndrome in characteristic form, with typical postural reaction to the headache and even syncopal attacks, yet the vasomotor instability had antedated the relatively slight injury, and the whole syndrome was considered to be a result of constitutional psychoneurosis.

Case 2. Corporal Y., aged 22 years, sustained small cuts in the scalp from fragments of a bomb in May, 1940, and was concussed for 5 minutes. The scalp wounds healed rapidly, and he did not complain of any further disorder. In August, during another bombing, which did not harm him, he developed headaches on exertion, dizziness on bending, emotional liability and insomnia. These symptoms increased in intensity, and after 4 months of disability from them, examination revealed an excessively nervous man without sign of damage to the skull or nervous system. He admitted tremor during the second bombing, and that he had at that time deserted his post to take cover, even though he had not been discovered. He confessed inability to face further service, and further disclosed a matrimonial tangle of considerable proportions. X-ray films disclosed, unexpectedly, several bomb fragments in the brain (Fig. 1) and a small parietal portal of entry only a few millimeters in diameter. The patient failed to make adequate response to psychotherapy, and since there was a family history of severe nervous breakdown, he was discharged.

In this case, in spite of the presence of foreign bodies, the post-traumatic syndrome was considered to be purely psychoneurotic.

The following case is an example of local cerebral contusion without concussion.

CASE 3. Guardsman A. C., aged 23, was injured on May 15, 1940, defending a canal bank at Louvain. He was struck tangentially by a bullet, which tore a 7.5-cm. hole in his steel helmet and made a cut 3.5 cm. long in the midoccipital scalp, 5 cm. above the occiput. He did not lose consciousness, and fired three more shots, but could not see plainly — "like through a mist." He crawled back to a trench and walked a mile to his medical officer. In this time, his vision was becoming dimmer, and when he arrived at his dressing station he could not distinguish light from dark. The wound bled severely and after morphine the patient remembered no more until 2 hours later, when he awakened in a casualty clearing station

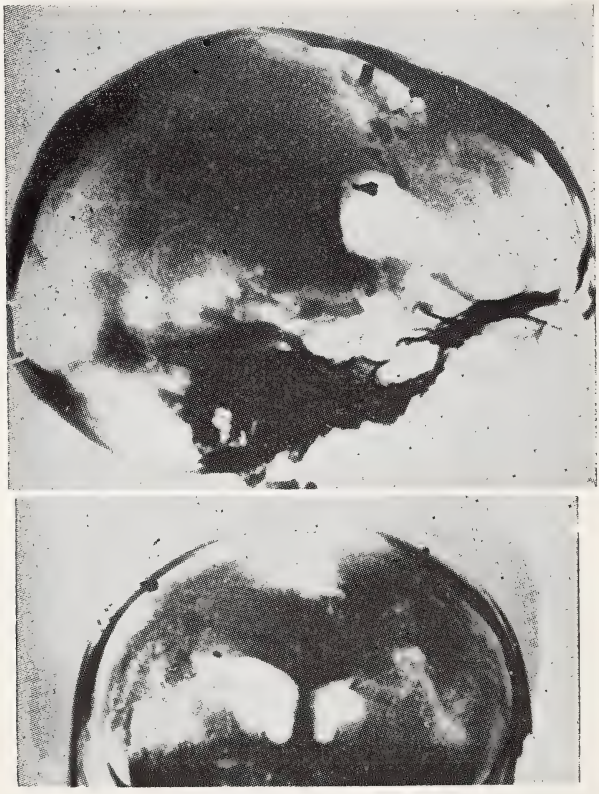

FIGURE 2. *Case 4.*

The lateral view of the skull shows metal and bone fragments. The portal of entry is very small and partly obscured by the lowest metal fragment. The ventricles were partially filled with air, and the patient was lying occiput down, so that there is a fluid level. The anteroposterior view shows distortion of the ventricle toward the fragments. All disability was nevertheless relieved.

with severe headache but could see a little better. For the next few days, intermittent, severe frontal headache, radiating to the nose, lasted for hours and continued for the next 3 weeks, at first daily, with three bouts in the last week. Vision slowly improved, at first for near objects, with a shimmering mist blurring anything farther away than his own hand. No

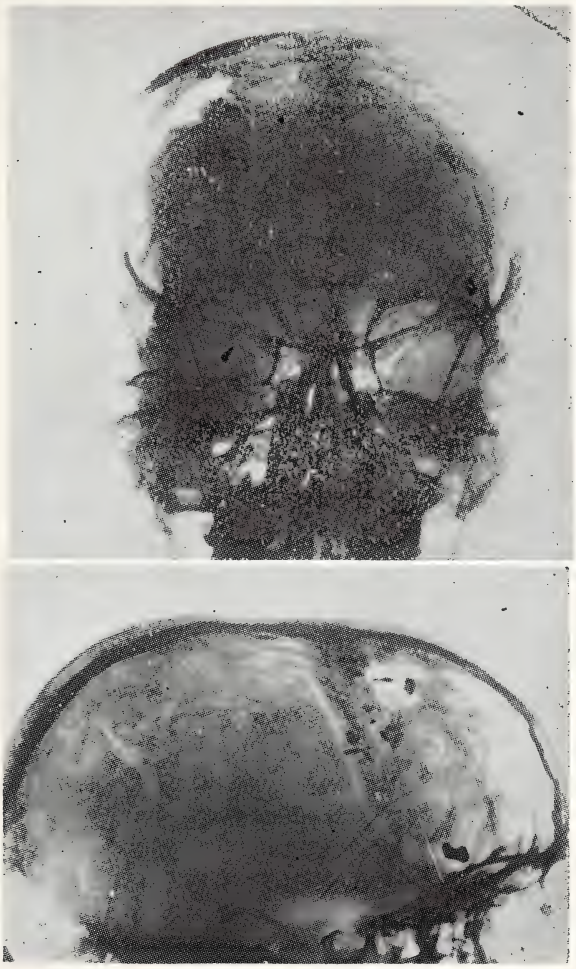

FIGURE 3. *Private W.*

These are lateral and posteroanterior views of the skull of a patient who was not concussed by the penetrating bomb fragment which crossed the frontal lobes to lodge above the opposite orbit. Flakes of bone lie directly beneath the point of penetration. After débridement, including removal of the bone flakes but not the metal fragment, he made an excellent recovery, without epilepsy or other disability.

hallucinations occurred. The headaches usually appeared in the afternoons, and were immediately made worse by any movement. At other times, a cough caused a sharp stab but no lasting pain. Bending made the pain worse; later, the patient was more comfortable when lying down. In the 4th week, he could read small print, but the effort precipitated headache. In the 6th week, reading no longer caused headache, and his distant vision was clear for the first time. Headache on exertion became very infrequent, although of the same type and lasting for some hours. By the 9th week, the patient had ceased to have headache except after very severe exertion or excitement, and felt well in all other respects. There had been no faints, and he had slept well all through. His vision was 20/30 in each eye, there was no field defect, the wound had satisfactorily healed, and x-ray films showed no bony damage. After a graduated convalescence, he returned to duty and remained well for at least a year.

This patient evidently suffered a contusion of the occipital lobes, but was not concussed. The local brain injury conditioned a post-traumatic headache, but at no time was there any symptom that could be construed as being emotional or psychoneurotic. The subsidence of the headache paralleled the disappearance of the contusion as judged by the disappearance of the visual symptoms.

A similar history, with concussion and brain injury and spontaneous recovery follows:

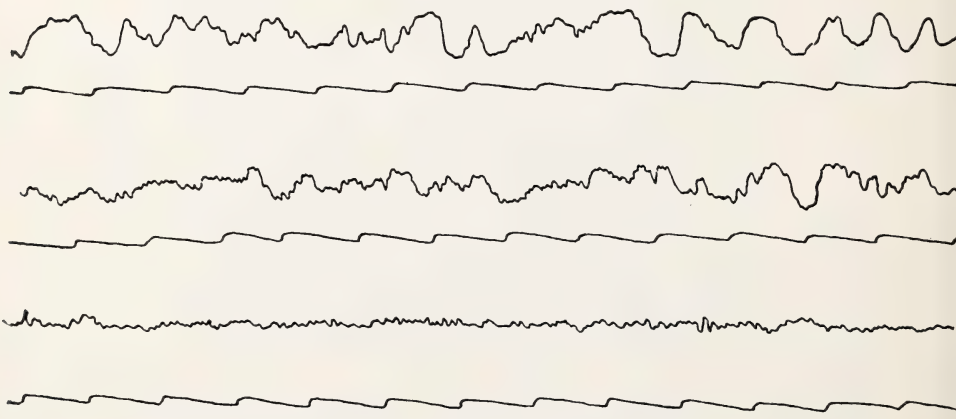

FIGURE 4. *Case* 5.

These electroencephalograms were made from bipolar parietal leads on the left side: *A,* seven days after the injury, *B,* three weeks after the injury, and *C,* ten weeks after the injury. The time tracings show 1-second notches. The disturbance was identical in all other leads on both sides at each stage.

Case 4. Private R. W. D., aged 21, was injured in Flanders on May 22, 1940. He remembered the whistling of a bomb and that he threw himself on the ground; he remembered vaguely an explosion and lifting sensation and then nothing until he was being bandaged with a field dressing less than 5 minutes later. His steel helmet had been blown off by the bomb explosion, and he had a scalp wound; he had difficulty in expressing himself, although he was well aware of his surroundings. He had headaches but no giddiness for the next 2 weeks. After 2 weeks, he could speak a few words, and gradually his speech returned completely in the next 2 months. He had at no time any difficulty in understanding written or spoken speech or in writing what he wished to say. After 3 months, he complained only of headache after severe exertion. Examination at this time revealed a slight right facial weakness, and a stellate scar in the left frontoparietal region, but no other abnormality. Speech was occasionally hesitant. X-ray films showed a small opening in the left parietal bone, with small fragments of bone and bomb splinters in the brain and with some enlargement of the ventricle by the resultant scar, as shown by air encephalograms (Fig. 2). Electroencephalograms showed a persistent low-voltage-wave focus just posterior to the wound of entry. No further surgical treatment was advised, and with graduated exercise the patient was entirely free from headache by October, returning to duty in November. He had remained well when last heard from, approximately 6 months later.

The patients in Cases 3 and 4 had excellent personal and family histories, and this no doubt contributed to their complete recoveries, despite severe local brain injury. They were cited to show that contusion, concussion, foreign bodies and even scarring of the brain substance are not necessarily factors in inducing continued headache. Furthermore, "organic" headache is not necessarily associated with postural giddiness. There were a number of other similar cases of gunshot penetration with complete recovery. In one such patient, a fragment traversed both frontal lobes (Fig. 3).

Three cases of transverse through-and-through bullet wounds of the frontal lobes showed severe intellectual impairment but no evidence of post-traumatic syndrome. Other cases, with severe paralysis, also failed to develop the syndrome, but possibly because the disability prevented exertion, which is one of the provocative factors.

Another type of case, however, is more frequently associated with persistent post-traumatic syndrome, and in its severest form is

usually called "traumatic delirium" or "traumatic stupor,"[32] according to whether or not restlessness is prominent.

CASE 5. Sergeant R., aged 24, sustained a bilateral wrist fracture and a scalp bruise on the right temple in a motorcycle injury on November 14, 1940. He was admitted in coma,* with bleeding from the right ear. The pupils were small and equal, the tendon jerks brisk, and the plantar responses flexor. The pulse was 128 to 132, and the blood pressure 135/90. After 24 hours, the patient responded to questions by inarticulate noises, and resented interference; there was photophobia, and the plantar responses became extensor. After 4 days, he began to make intelligible remarks, such as "What's that?" "Don't do that" and "Is Mother there?" He was deeply confused, and the next day, in response to the question about how he felt,

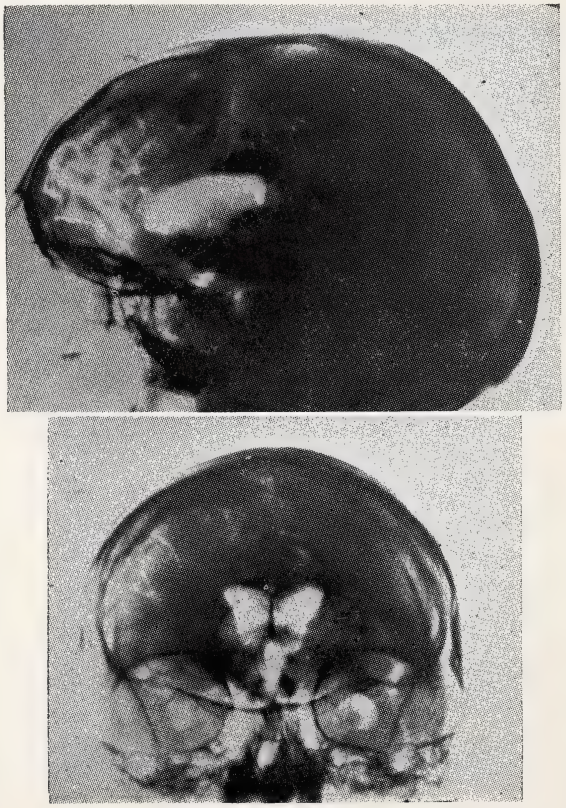

FIGURE 5. *Case* 5.
These lateral and anteroposterior views (occiput down) of the skull, after air encephalography, show general dilatation of the ventricular system.

said: "Not too bad, doctor. I go to the hospital every morning." His restlessness increased, especially at night, and he shouted if interfered with. He was doubly incontinent. After 14 days, he could mumble his name and address in response to questioning, and occasionally showed his teeth or followed a finger with his eyes, if requested. The plantar responses returned to normal, and the incontinence lessened and disappeared. The patient remained grossly disoriented in time and place, and had no memory of the day before, or even what meals he had had that day. X-ray examination of the skull was entirely negative. The cerebrospinal-fluid pressure was 170 mm., and the protein was 35 mg. per 100 cc.; no cells were present.

Gradually, co-operation and orientation returned, passing through a stage of confabulation, with some perseveration in speech and ideas but no dysphasia. The memory was severely affected, and the patient often relived events of years or months before. Christmas Day, in the 6th week of his illness, was the first current event to remain in his memory and also subsequently marked the end of post-traumatic amnesia. The retrograde amnesia, at first of 3 months with "islands," gradually narrowed down to an irreducible minimum of a week.

The patient steadily improved, but with persistent slowness and difficulty in concentration. His memory remained grossly defective (except for retaining serial digits, but he had been an accountant). He was emotionally labile and disturbed by his difficulty in concentration.

Not until he began to get up each day did he complain of headache, generalized, increased by movement, concentration, noise or cough and lasting for some hours on his return to bed. He felt giddy if he turned quickly, and occasionally faint. When, after some weeks, he was given graduated exercise, he reacted by a "catastrophic reaction," failing suddenly on every test at an easy stage, and became depressed and introspective. Only with return to lesser grades and with great patience was he induced to further graduated activity. When well enough to care for himself, he was discharged for further rehabilitation in a civil hospital.

Throughout his illness, this man showed gross electroencephalographic abnormality. Large slow waves at the rate of 1 per second were present throughout the two hemispheres for the first fortnight (Fig. 4), and then gradually lessened with the appearance of faster rhythms. After 3 months, the base line still showed traces of the slow waves. There was not at any time a focus of abnormality.

This patient never showed any evidence of damage to a localized part of the brain. There was no evidence of fat embolism, although the urine was not examined for fat. The cerebral disorder was generalized and severe, and was followed by persistent intellectual deficit. It is an open question whether the emotional disorder and the post-traumatic syndrome were

* The Committee on Brain Injuries of the British Medical Research Council has compiled a standard definition of terms commonly used in head injury.[33] Coma or semicoma is preferred to "unconscious," and defined in terms of reaction to stimulus.

directly induced by the injury or were a psychoneurotic reaction to the patient's awareness of his mental limitation. The family and past histories were irreproachable; he had been a successful businessman before enlistment. An air encephalogram after 3 months showed generalized dilation of both lateral ventricles, indicating generalized cerebral atrophy of mild degree (Fig. 5). In view of the persistent electroencephalographic abnormalities, which after 3 months took the form of small runs of slow waves at times (possibly indicating some tendency to epileptiform manifestation), the whole disturbance was regarded as directly consequent on the traumatic damage to the brain, and visualized as an extreme example of concussion.

Slighter varieties of this type of disorder, which might be called traumatic coma followed by confusion, are not uncommon. All degrees are met, down to such brief events as are more usually termed concussion, with correspondingly lesser degrees of, or absence of, residual intellectual impairment. An intermediate degree is illustrated by the following case.

CASE 6. Gunner J. B., after a motorcycle accident, was deeply comatose for 24 hours, and confused and restless for 21 days, with normal cerebrospinal-fluid pressure and contents. The electroencephalogram showed large slow generalized waves all this time. After a slow convalescence, — 3 months, — the patient was able to saw logs without symptoms. The electroencephalogram was not quite normal, and all memory and other intelligence tests gave a poor response (for example, the patient retained only six digits). On return to duty after 4 months, never having had a headache, he immediately broke down, became very emotional, complained of severe headache on any exertion and of giddiness on bending or turning suddenly or on looking up or down, insisted that he was anxious to return to duty, and rapidly responded to psychotherapy. At the urgent request of his commanding officer, he was allowed to return to duty after further convalescence, subsequently relapsed and was eventually invalided permanently unfit. (This case has been reported fully, with electroencephalographic records, by Williams.[34]) The electroencephalogram still showed traces of slow waves at 3 to 8 per second after 5 months (Fig. 6).

The ultimate breakdown in this case was clearly psychoneurotic and was conditioned by anxiety about the future. Nevertheless, it must be admitted that a certain degree of impairment of judgment could still be demonstrated by careful tests, that the patient always had been a poor scholar, although his family and personal histories were otherwise good, and that such intellectual impairment as

directly resulted from the injury may in fact have been the only cause of the failure to reattain an already limited adaptation to army life.

One may contrast patients who suffered comparable direct cerebral gunshot injuries, both perhaps with some slight residual disability, and whereas one made an excellent recovery, the other was held back by general post-traumatic symptoms. The failure of the second was regularly traceable to one or both of two factors: unduly prolonged coma and confusion following the injury, indicating concomitant severe generalized disturbance; and a history of liability to psychoneurosis or failure in adaptation in the personality or family history. In this group also fall the morons and chronic psychopaths whose capacity for adaptation is already limited.

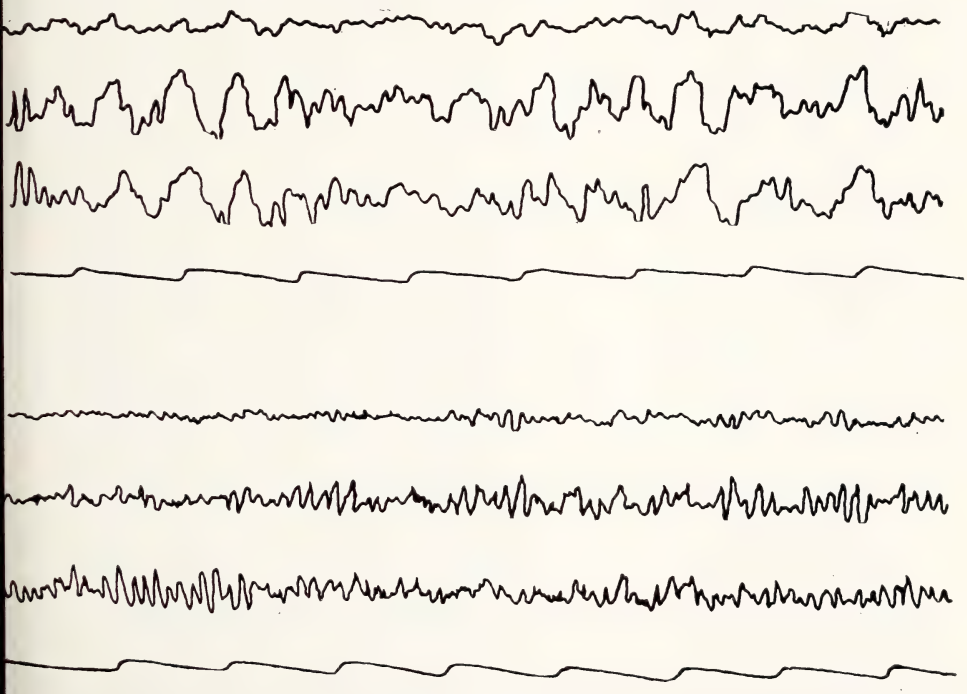

FIGURE 6. *Case 6.*

Each of these two sets of electroencephalograms was made from frontal, parietal and occipital leads, placed from above downward: *A,* twenty days after the injury, and *B,* five months after the injury. The time intervals are one second apart. In *B,* traces of 2-second and 3-second waves are still seen.

Estimation of Degree of General Injury

Much depends on how severity of injury is defined. It soon became apparent to me that a "severe" injury is not necessarily associated with an extensive wound, laceration, depressed fracture or other surgical complication. I refer to the type of case in which unconsciousness is prolonged for a day or several days, and succeeded by confusion or delirium for many more days. Such a state is commonly called "cerebral contusion"[32, 35] or "cerebral edema"[36] — according to the particular theory to which the diagnostician adheres, and supported by evidence of subarachnoid hemorrhage or focal signs on the one hand or increased cerebrospinal-fluid pressure on the other. But, with increasing experience, one soon finds that cases, such as Case 5 cited above, occur without either of these signs, or hemorrhage or increase of pressure. Furthermore, accessory methods, such as the air encephalogram, which gives very definite evidence of any local lesion, may fail to give any such indication. The injury should nevertheless be called severe. Conversely, many patients suffer epidural or subdural hemorrhage and make a rapid and permanent recovery immediately after its surgical relief. From the point of view of the persistent effect on the brain, such complications of injury must therefore be termed slight. When persistent symptoms follow relief of such a complication, the cause must be sought in some further condition—psychoneurotic, general intellectual impairment or some other.

The difficulty most writers have in accepting the entity "concussion" is that it is defined only in negative terms. If one accepts absence of contusion, edema and hematoma as its characteristics, how is one to know that a minimal degree of any or all of these entities is not present, or not detectable by the relatively coarse methods of examination? The answer is twofold: concussion has been shown experimentally to occur as an *immediate* paralysis without such changes (Denny-Brown and Russell[22] and Williams and Denny-Brown[23]); and the electroencephalogram gives a clear indication of the presence of this condition. In traumatic coma and

confusion, great slowly rolling electrical fluctuations at a rate of 1 per second occur uniformly over the entire cerebral cortex. Greatly increased intracranial pressure sometimes causes a similar state, and this possibility should be eliminated. As coma passes into confusion and delirium, faster rhythms appear. Long after the confusion has passed the normal rhythm has been established, slow undulation of the base line reflects the ground swell of the previous storm. This electrical disorder observed in my cases has been analyzed in detail and reported independently by Williams,[11, 34] who was electroencephalographer to the hospital. The important clinical features are that the disorder is generalized (the electroencephalogram of focal contusion is focal), that it can occur without increased pressure or blood in the cerebrospinal fluid, and that it can subside at variable speeds in from less than an hour to six months.

It is submitted, therefore, that a severe generalized disorder — for which there is at present no better name than concussion, traumatic confusion or stupor[37] — may occur without the surgical complications that are generally described. If the progression of such coma were followed through a period of confusion lasting days, or even only one day to recovery, one would undoubtedly rate the disturbance as severe. More difficulty arises in the interpretation of the electroencephalogram if the patient is seen for the first time months after the injury, especially when, as is common in war, accurate details of the illness are no longer available. The patient has no memory of his condition. The skull or x-ray film, or at this late date the electroencephalogram, may show no objective mark of the injury or only such slight disorder as to be within the possible limits of normal variation. How, then, should the illness be judged?

The most reliable criteria found have been the duration of the post-traumatic amnesia (Russell[16, 19]) and the defects in the intellectual status. Supporting evidence may or may not be had from the air encephalogram (dilation of the ventricles) and electroencephalogram, depending on the time since injury.

Recently some remarks have been made deprecating acceptance of the patient's statement of his own amnesia as evidence of injury,[36]

so far as industrial and civil accidents are concerned. Although such an objective approach to this problem is desirable, a critical questioning of the patient by a trained observer soon reveals whether his story of amnesia rings true or not, and experience in assessing large numbers of such cases has confirmed this view.

The investigation of an amnesia is too large a subject to be dealt with fully here, but the following general statements may be helpful. True concussion should be followed by retrograde amnesia, which should gradually shrink to a fixed absolute minimum. Thus, the concussed patient should not recollect the injury. The post-traumatic amnesia should not have a sharp end point, and persistent errors in judgment and difficulty in concentration should long outlast it. What the patient was told of his behavior while in the hospital should be consistent with the type of recovery known to follow a state of true confusion — for example, his inability to recognize relations or friends in spite of recovery for simple conversation. That hallucinations or manic behavior color this stage is an indication of the personality of the patient rather than of the actual nature of the injury. Thus the trained and experienced observer will know whether amnesia is true or false. False amnesias include those of simulation and those of hysterical states. In doubtful cases, these can be recovered by treatment with Amytal or other hypnosis, whereas true traumatic amnesia cannot. If surgical complications occurred, it is essential to know whether amnesia terminated with their relief. If not, a state of general confusion may be assumed to have coexisted and undergone independent later recovery. Subject to these limitations, then, the duration of blank in memory in the mind of the patient from the time of injury onward is a very good index of the severity of generalized or concussive effect. It indicates the total duration of coma and subsequent confusion, and thus the general severity of the injury may be estimated. The onset of the amnesic period should have been immediate. When the amnesic state had an onset at an interval after the injury, a surgical complication — such as subdural or extradural hematoma — or a hysterical episode must be suspected.

After evidence of a severe or moderately severe injury has been sought, inquiry is directed to signs of persistent damage to cerebral function. The most crucial and difficult to define is intellectual deficit. There may be a history of defects in judgment or slowness in cerebration, or of apathy since the injury. It is only to be expected that such a widespread intellectual disorder as disorientation and confusion lasting for several days or weeks should leave its mark on later intellectual function, and the clinical application of any good tests of intellectual status will define the defect. Some estimate of the intellectual level of the patient before the injury, on a basis of education and employment, must be made. In coarser degrees of deficit, tests for memory, such as digit retention, the serial subtraction of 7, test stories and general information, show marked deficiencies. In the slighter degrees of disorder, tests of judgment, the use of intelligence scales, such as the Matrix test, general tests, such as the Rorschach test, detection of absurdities and so forth, may be required to define the persistent defect.

To clarify my approach to the problem, a type of case is cited in which the injury induced a generalized cerebral disorder of relative purity (traumatic delirium or traumatic stupor). I believe that such disorder exists in some degree in all severe and many moderately severe head injuries, complicated by various combinations of contusion and edema, laceration, hematoma, subarachnoid hemorrhage, and fracture. However dangerous or alarming these complications may be immediately after the head injury, experience has shown that no one is alone responsible for long-continued disability. *The essential factor that retards or prevents full restitution of cerebral capacity is the generalized cerebral disorder,* of which the best indices are the duration of true post-traumatic amnesia and a residual intellectual deficit.

In the last thirty years, a continuous search or objective evidence of the post-traumatic cerebral syndrome has been made.[18] Such criteria as increased reflexes, loss of visual convergence, change of pulse rate with posture[38] or with adrenalin, rise of cerebrospinal-fluid protein, slowness of cerebrospinal-fluid resorption,[39] persistent

rise of cerebrospinal-fluid [39, 40] pressure, and, paradoxically, persistent lowering of cerebrospinal-fluid pressure[41] have all had their advocates, but none have stood the test of experience. The first three listed, for example, are common in psychoneurotic states; a high cerebrospinal-fluid protein is very seldom seen and, when present, indicates organic damage. A long-maintained, definite abnormality in cerebrospinal-fluid pressure is not found. Within two months of the injury, the spinal-fluid changes, if any, have vanished and are no longer of value in assessment. It is worth noting, however, that anosmia is frequently found as the only organic sign, associated with the severer degrees of intellectual impairment, apparently because blunt injuries, over the occiput in particular, result in severe cerebral commotion and at the same time cause tearing of the olfactory filaments. A vertical

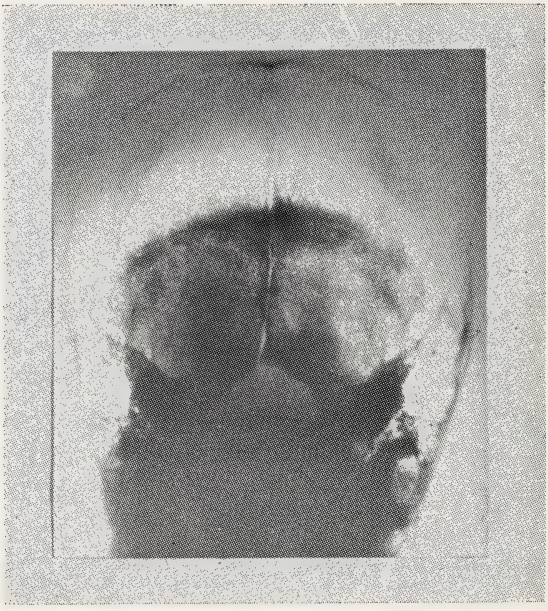

FIGURE 7. *Lance Corporal S.*
This is a half-axial view of the skull of a patient who suffered intellectual impairment following a severe injury, the only other signs of which were anosmia and a crack radiating posteriorly from the foramen magnum.

fissure in the occipital bone, radiating up from the foramen magnum and seen only in axial view (Fig. 7), may be present with the anosmia.

Ancillary methods, such as *air encephalography* (cisternal method) and *electroencephalography,* have served to clarify our ideas by lending objective evidence of damage to the cerebral structure. The second of these was used routinely, and the first in all difficult assessments and many others. Both methods suffer in their effectiveness because the slighter changes that can be thus demonstrated are also found in patients without head injury. Only rarely were they decisive in estimation of the patients who were difficult to assess by other means. Conversely, defined change in either method alone, sometimes in both, could be consistent with successful return to duty if clinical considerations indicated it (Case 4).

Intellectual status alone is likely to give a false impression of general cerebral defect in cases in which aphasia has complicated a left-sided parietal or frontal focal lesion. Mild confusion may then impair all general intellectual function up to a late stage in recovery, but with much better ultimate prognosis than after a corresponding disturbance due to general injury. Special tests are necessary to elicit the special nature of this disturbance of function. In early convalescence, electroencephalography indicates the limited nature of brain damage in these cases, and as the localized electrical disturbance fades away, cisternal air encephalography begins to show the ventricular distortion due to the localized frontal or parietal atrophy (Fig. 8). An even, generalized dilatation of one ventricular horn caused by mild loss of brain substance following contusion (Stevenson[4] and Greenfield[42]) is of better prognosis than the peaked, tentlike traction defect due to an epileptogenic cerebrodural scar of the type described by Penfield.[10] The former condition is by no means incompatible with return to duty, although a period of four to six months may be required before full efficiency is gained. In men and officers with long service, special qualifications and reasonably good nervous constitution, the decision that

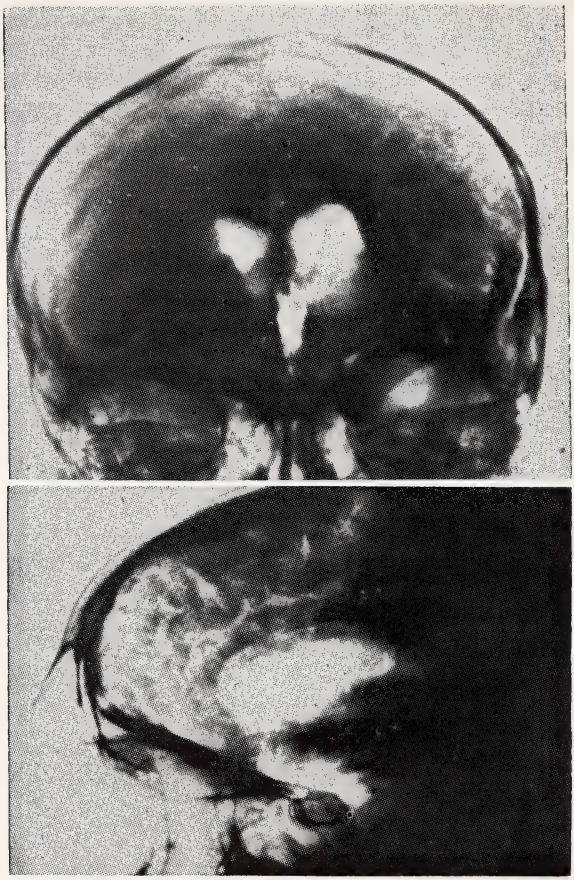

FIGURE 8. *Sergeant P.*

These are anteroposterior and lateral views of the skull of a patient in whom severe persistent dysphasia occurred following a blunt, nonpenetrating left temporal injury with skull fracture. Air encephalography shows a great widening of the frontal and temporal horns of the left ventricle.

treatment should be persevered with for this period rests on a careful study made in the early stages. Such a decision in a military hospital concerns the need for avoiding the blocking of beds by patients who will never be acceptable for further duty. The accuracy of forecast in these cases depends on ability to eliminate a general

intellectual defect in the presence of a focal lesion. It is necessary to distinguish the more diffuse types of dysphasia (amnestic dysphasia) from true residual aphasia, and likewise the recoverable kinds of monoparesis and hemiparesis, if accurate prognosis is to be achieved.

In thus presenting the clinical criteria on which the organic type of post-traumatic general cerebral syndrome is judged, some general considerations emerge. My experience has shown, as Symonds[43] had long maintained, that many patients labeled "post-concussion neurosis" or "compensation neurosis" in civil practice have in fact suffered severe cerebral injury as gauged by the above criteria. Most cases of so-called "pure traumatic neurosis" in a well-adjusted personality have been found to belong to this group.

Traumatic intellectual impairment may coexist with local cranial, facial or cerebral injury or with frank neurosis. The gravity of the general cerebral disorder in addition to such complications may have been apparent in the initial illness. Months after an injury about which adequate data are lacking, and for which the patient has a prolonged true amnesia, it may be extremely difficult to decide whether concussion did not in fact merge with contusion, hematoma, fat embolism or similar complications. Records of the duration of coma and the presence of aphasia, hemiplegia and so forth are difficult to obtain from field hospitals, but are so vital in the subsequent medical history of the soldier or airman that a special field card for head injuries was devised, with a simplified check system for rapid use in the field. The most urgent decision, however, is whether or not intellectual impairment is the substratum of the patient's present symptoms. If it is, improvement is obtained only by readjusting the patient's life to his disability.

Thus, I am not convinced that the cause of persistent organic disability lies in edema or other disturbance of fluid balance, or in adhesions of meninges (epilepsy excepted). Evidence of persistent paralysis or, more commonly, of intellectual impairment, is regarded as the essential factor.

Nonorganic Factors

A large group of cases with a disability syndrome that is labeled "psychoneurotic" remain to be discussed. Many of these present the post-traumatic general cerebral syndrome following a trivial injury. The characteristic headache usually develops only after an interval that may be of a day or longer, perhaps weeks. There is often no trace of injury, intellectual deficit, abnormal electroencephalogram or other change at any stage. A carefully taken history, however, elicits evidence of nervousness and anxiety, especially fears of serious consequences to health or to ability to continue earning.

A severe emotional reaction at the time of injury commonly occurs. Prolonged insomnia is its most reliable index. This immediate emotional reaction is not to be confused with the later emotional upheaval when, after severe injury, the patient first develops awareness of his calamity.

The disabling symptoms do not differ from other forms of anxiety neurosis except that headache is a prominent symptom. It is usually dull, generalized, steady and persistent, little or not at all relieved by rest, as in simple anxiety or depressive illness. In a small proportion of cases, about one tenth, headache and dizziness on bending or on exertion, exactly comparable to that seen in the post-traumatic syndrome with severe brain damage, make their appearance. Schilder[44] and others have suggested that the prominence of headache as a psychoneurotic reaction to head injury is related to a consciousness of the head or to ego. I believe that in the true syndrome some as yet undefined physiologic mechanism is at fault. Common association of the post-traumatic syndrome with poor physical development and with vasomotor instability, such as pallor and faints, often antedating the head injury, suggests a common background. It is remarkable that such a syndrome should respond to psychotherapy, and it is therefore concluded that it can be a psychoneurotic manifestation. Intolerance to alcohol, a well-known aftereffect of organic cerebral damage, also occurs in some purely psychoneurotic cases after trivial head injury. Headache may

coexist with or be replaced by simple anxiety, fears, depression or hysterical fugues or blindness.

Psychoneurotic types of reaction to head injury are usual in mild mental defectives and psychopaths. Such persons suffer unduly prolonged disablement from head injury; usually, the post-traumatic syndrome is a sign that their adaptation to the stresses of the world, already precarious, is easily disturbed by such an event as head injury. In civilian practice, morons and aged persons are also more sensitive to disturbance of an already precarious equilibrium.

An interesting variety of the psychoneurotic type of syndrome is that seen after repeated injury, such as occurs when a dispatch motorcyclist — in peacetime a performer in "dirt-track" racing in which he had sustained a number of head injuries without persistent effect — breaks down following a further relatively mild head injury. The mechanism is again that of loss of adaptation to stress. A predisposed temperament, carried through a series of events by a general optimism, eventually loses adaptation following a further trauma in the face of added anxiety but no greater actual danger or damage. This is to be distinguished from the condition of one who is "punch drunk," clearly an organic syndrome of cumulative kind.

It must again be emphasized that patients suffering from true traumatic intellectual impairment may break down in a psychoneurotic manner. If the original head injury was at all severe, the greatest care must be taken to exclude this possibility. If such impairment exists, the disorder is labeled "organic," for although the symptoms may respond rapidly to psychotherapy, no lasting relief can be obtained without adjustment of exertions and responsibilities to the level of lowered general capacity.

Disturbances variously labeled "black-outs" and "loss of memory" are extremely common during convalescence from head injury, and differ in degree, from brief periods of behavior, not remembered owing to lack of concentration, to hysterical fugues, which are usually motivated by some anxiety. These disturbances are usually

on a functional or psychoneurotic basis, but experience has shown that in a few cases such dissociated states were associated with true epilepsy attributable to the brain injury. Thus, traumatic epilepsy, which causes dissociation (automatism), may facilitate a motivated amnesic wandering in a patient also subject to anxiety. In such cases, the usual treatment for psychoneurosis is naturally ineffective unless the organic substructure is recognized and also receives treatment.

In Britain, the diagnosis of "shell shock" is no longer made following the findings of a special committee in 1922,[45] and of another in 1940,[46] which recommended that the condition be resolved into its psychoneurotic or organic constituents. The common "shell shock" was none other than the psychoneurotic type of post-traumatic reaction. The group also included some cases of residual intellectual impairment from severe general brain injury as it is now recognized, and some of more obvious anxiety neurosis. Such disorder resulting from bomb or shell blast does, in fact, still occur, and close examination of the amnesia reveals its hysterical properties. In supposed cases of concussion due to blast, the patients turned out either to be of this type or to have suffered a secondary injury to the head from being thrown against a hard object, or struck by falling masonry, as in Eden and Turner's[26] cases.

The following case is an example of hysterical amnesia.

CASE 7. Private A. C. L., aged 29, survived several severe bombings without symptoms. He had an excellent family, personal and occupational history. On May 30, 1940, a shell dropped within several yards of him in a trench. He remembered nothing for 3 hours, and recovered consciousness walking in a wood "crying like a baby" (his own words) and shaking all over, about ¼ mile behind the line. He had a severe headache but when examined at a dressing station had no sign of injury. He was transferred to a hospital, and continued to suffer from severe headaches, worse in the mornings, and severe insomnia. He trembled on hearing an aircraft and kept thinking of a friend of his who had earlier been killed. The symptoms persisted, and on admission under my care he was found to have no sign of injury, normal x-ray films and an excellent intellectual status. The amnesia was found under Amytal narcosis to be hysterical, and with simple psychotherapy all symptoms rapidly resolved and the patient returned to duty without relapse.

The type of anxiety varies from patient to patient. In the airman, conscious or unconscious fear of further flying accidents is a natural anxiety that must always be taken into account, no matter how trivial the injury or how obvious the structural damage. The loss of an eye, or of vision in one eye conditions anxiety regarding the remaining eye. A gap in the skull, itself reasonably safe from damage, except by sharp objects, is a source of fear to the owner despite the firmest assurance to the contrary. Unreasonable fears are usually based on the gravity with which some uninformed physician has at sometime viewed the scar or injury. Those who "take a grave view" and display to the patient some uncertainty regarding the ultimate outcome little know how lasting a fear is implanted in the patient's mind, or how disabling and difficult to treat the consequences may be. Often, the sole reason for an anxiety neurosis turns out to be some casual conversation with a friend who remarked that he knew of another who had suffered a similar injury and "never got over it." This common explanation of secondary anxieties resulting from head injury is, I am sure, the basis for the immensely superior results obtained when the convalescence from head injury is managed throughout by a thoughtful physician well aware of the psychologic dangers besetting his patients, and when all patients with recoverable disability are early segregated from the severer ones.

With some experience, it is soon realized that a positive constitutional nervous history, in addition to a poor response to intensive, although simple, psychotherapy, will prevent any return to military duty. It is, however, often of value to have a different psychotherapist attempt treatment for a brief trial period before discharge from the service is advised, for psychotherapy is an intensely personal affair. Decision is nevertheless usually made rapidly in the severe case.

The greatest difficulty arises in the *borderline case* — the patient who makes a good response to treatment but is liable to relapse in the stress of battle. Such difficulties in England were complicated by the fact that there was no really "safe area" to which a soldier

or airman could be transferred for a period. Relapse could occur as readily with bombing as with service overseas. No matter how many relatively minor or routine posts there may be in any army battalion or air-force ground staff, a man subject to relapse is always a liability to his commander. This was abundantly clear in the fighting in Belgium, where war-weary troops literally carried their neurotic comrade with them.

In the borderline cases, the critical factors in head-injury neuroses are exactly the same as those in other war neuroses with the addition of anxiety concerning the possibility of brain damage. Lewis and Slater[47] have recently studied the relation of various factors to prognosis in neurosis in soldiers, comparing two groups of 150 men, all considered by medical boards to have made fully recovery. One group was successful in returning to full military duty for at least three months, the other group having been fit and returned to duty but having relapsed sufficiently to require subsequent discharge from the service. These authors list twenty attributes, which are as follows: *family history of nervous or mental breakdown,* poor school record, unsatisfactory childhood, *unsatisfactory work record, previous psychopathic traits or nervous breakdown or symptoms,* time in hospital, *dislike of Army life in past,* keenness to return to Army, military stress (for example, Dunkirk), adequate external anxiety (domestic or financial), disillusionment, physical factors, conversion symptoms, *querulous hypochondriasis,* depressive symptoms, anxiety symptoms, *amnesic episodes,* surly or *paranoid attitude,* fits and faints. The italicized factors are shown to operate powerfully in favor of relapse, but the analysis also shows clearly that no one of these factors is alone sufficient for unsatisfactory return to duty; it is any combination in this series that counts. Exposure to severe military stress and keenness to get back to duty are shown to operate clearly in favor of successful return to full duty. This is entirely in accord with my own experience with head-injury neurosis. However, to the italicized group, I should add disillusionment, anxiety about brain damage and fits. The decision to return to duty in borderline cases depends on the number of these factors,

their duration and the nature of the stress that precipitated them.

Much has been made of ventricular dilation demonstrable by air encephalogram in cases of head injury since attention was first drawn to its occurrence by Bielschowsky.[39] It has been held to demonstrate an organic basis for psychoneurotic symptoms.[48, 49] My experience has led to the opinion that, although it means loss of cerebral substance and damage to axis cylinders and myedlin,[50] ventricular distortion by no means settles the nature of the patient's disability. As in Case 3, it is frequently present when no persistent disability has occurred, and also in many other cases in which the disability is demonstrably a psychoneurosis and is amenable to treatment. This may also be true of persistent electroencephalographic abnormality, which must be considered in relation to other factors, such as nervous constitution and intellectual impairment, before it can be regarded as significant.

It is of considerable interest to compare the conclusions reached by us with the excellent clinical analysis of civilian compensation cases made by Schaller.[17] Whereas our findings agree in broad essentials with his two clinical syndromes (post-traumatic concussion state and post-traumatic psychoneurotic state), which are common and characteristic, no single clinical feature is diagnostic, and every variety of intermixture can be found. Moreover, the psychoneurotic patient is often anxious to resume occupation, and more frequently exhibits difficulty in concentration, precise symptomatology and tendency to improve than the patients in Schaller's series. Our organic cases also showed more liability to functional overlay, more frequent headache and less aggressiveness than those of Schaller. Although the extreme clinical syndromes are characteristic, no single clinical feature is diagnostic. Nor do we consider the conception of "post-traumatic general cerebral syndrome" of Foerster[14] as a clinical entity of practical value. Of such a variable series of clinical pictures as those persisting from head injury, no two or three broad divisions are possible. Instead, each case should have separately estimated organic residua and psychoneurotic symptoms.

Psychosis

Frank psychosis resulting from head injury is extremely rare. Mania, deep depression or schizophrenia (1 of each in the 400 cases) may be precipitated by the general disturbance of the injury in a person with a strong predisposition. More commonly, the phase of confusion during recovery from a severe injury may be colored by elation, depression or hallucinatory experience. When confusion is prolonged, this phase may also be prolonged for weeks or months, but with a steady tendency to recovery.[43] A type of phonographic loquacity associated with catatonia was seen in 2 cases in this period.

Changes in personality and outbursts of irritability of marked degree are not uncommon (9 in the 400 cases), but there is usually some evidence of instability and swinging of mood before the injury. Obsessional traits may become extremely pronounced. Such changes are therefore regarded as usually being psychoneurotic, and are not directly comparable to the more complete change in personality seen sometimes in children after head injury.

Culpability

The greatest emphasis must be placed on the frequent combination of structural damage and psychoneurosis. It is impossible to keep these two pigeonholes entirely separate. It is both unjust and bad treatment to regard conscious or subconscious malingering as the only alternative to grave damage to the brain. Pure malingering is extremely rare, and its inconsistencies relatively easy to entrap. Psychoneurotic behavior motivated by dislike of military life is commoner. But most post-traumatic neuroses, especially the psychoneurotic factors that prolong disability from head injury, are deeper than this. Most commonly, they arise from a combination of natural anxieties with prolonged war stress. These and constitutional liabilities are beyond the patient's realization or control. Although careful psychiatric selection of draftees will minimize disorders due to constitutional psychoneurotic liability, it cannot entirely prevent them. Even in air-force pilots, very highly selected in this respect,

the constitutional factor was often elicited only by prolonged investigation after the disability had arisen.

Whereas psychoneurosis has not the stigma it once had, some further education of the general lay public is necessary in this respect, for in many cases war trauma is in part or wholly responsible for prolonged total disability of psychoneurotic kind, incurred through truly courageous and heroic acts. That it should occur very often in the course of simple devotion to duty should not close one's eyes to its essential nature and thus erect a barrier to efficient treatment. That the bravest man may develop a psychoneurosis through no fault of his own, particularly under circumstances of exhaustion and fatigue, was a fact well recognized as long ago as 1815 by Lord Wellington when he was consulted regarding a psychoneurotic casualty of the Peninsular War.[51]

When compensation is a factor, the issue should be fairly and squarely faced and decided forthwith. Compromise in this respect nullifies the effect of any kind of treatment. Once the issue is settled, in service as in civil cases, treatment should proceed, for the condition seldom subsides spontaneously.

Treatment

From what has been said, it should be clear that head injury is by no means a clinical entity for which a cut and dried line of treatment can be prescribed. This is as true of the persistent aftereffects as of the acute stages. Each case must be treated according to its particular merits. When the relative gravity of bony, cerebral and emotional factors and the effect of any foreign bodies that may be present have been estimated, the line of treatment to be pursued and its likelihood of success become clear.[52] Objective records, such as ventricular air studies and electroencephalography, are extremely valuable but seldom achieve a short cut to clinical evaluation.

It is not considered possible even to list a particular treatment for any particular symptom, for any symptom may have either psychoneurotic or organic emphasis and, if organic, a focal or generalized

cause. Thus, traumatic epilepsy may be related to transient effect of a single defined scar or diffuse degenerative process, may have an identifiable removable cause, or may be only the awakening of a latent liability by a generalized physical effect. This is also true of paralysis, or visual disorder, when only experienced, trained observers can give an estimate of the degree of unrecoverable disability. It is not enough to say that a patient cannot read because he has a visual-field defect. One must know whether that particular defect does in fact interfere with reading and, if so, whether a particular method of training can bring improvemnt, and if not, how to deal with the psychologic difficulty that blocks recovery. In the armed forces, it is further necessary to be able to give some estimate of the prognosis regarding ultimate resumption of duty, and the time likely to be consumed. The problem is then often complicated by the fact that the limitation in capacity may not enable the patient to continue holding his former appointment, and intimate knowledge of the service is required to determine whether such limitation is possible in other duty carrying the same rank, and, if not, whether the necessary change in status is likely to be the cause of a relapse.

The treatment of surgical complications is one of which the neurosurgeon can more properly speak. For all types of organic paralysis, such as spasticity, loss of sensation and of vision, and ataxdia, exercises are more valuable than any other form of therapy and, in addition to experience, enthusiasm and adaptability are of the greatest benefit in the physiotherapy division. Enough has been said to indicate that even the most apparent spastic hemiplegia should be carefully assessed for psychoneurotic and other complicating features before it is assumed that no further recovery is possible.

Psychologic treatment is most effectively undertaken and supervised by those who take the original psychiatric history, for the initial psychologic rapport and understanding thus obtained is a good starting point. For hysterical amnesia, hypnosis and prolonged association are effective but time consuming, and most experienced

workers shorten the procedure with brief Amytal narcosis, to break down inhibitions and take a short cut to suggestive treatment. All anxieties are fully discussed, and reassurance given. Encouragement and supervision in graded occupation and exercise are necessary. Communication with the soldier's commanding officer may be needed in matters of pay or discipline, and with the Red Cross or other social services or relatives for the patient's family troubles.

All cases of structural injury to the brain and skull require such prolonged convalescence that, unless some intersting diversion is provided, psychoneurotic complication or ordinary discouragement is liable to occur. Here is the place for occupational therapy, — leatherwork, basket making, bookbinding, wood carving and so forth, — which was early developed in our hospital and assumed a most important place in therapy. It should not be confused with rehabilitation, and nothing is worse than for these patients to get the idea that organized carpentry is to refit them for civilian life. They should recognize from the first that they are to return to duty, and should regard the treatment as a pastime. The best instructor gives most time to the clumsy performer, for it is he who is deriving most benefit. Others are apt to spend too much time with their more successful pupils, forgetting that they either no longer require instruction or should be promoted to more strenuous activty. The subject has recently been discussed by Jefferson et al.[53]

For the final stages of convalescence, a rigorous schedule is required. This was carried out in a special convalescent branch of the hospital with a resident medical officer. There was also a weekly visit and an interview of each patient by the medical specialists of the parent hospital. Graded physical activity and exercise, especially stooping, leading up to heavy digging, sawing wood, swimming, football and boxing, were essential. Only in this way could a disappointing relapse be prevented on return of the soldier to active military duty.

Throughout this performance, it is essential for a physician who knows the whole circumstances of the case to supervise progress.

Time must be given to regular discussion of all problems with each patient. Only then is it realized how small problems crop up from day to day, and how much individual attention to detail counts. And this extends, as will be explained below, to the personal and family affairs of the man.

The medical officer soon learns to recognize the "catastrophic reaction" (Goldstein[12]) — the gesture of failure by sudden abandonment of co-operation on the part of the patient. This requires patient and firm encouragement, the right mixture of sympathetic understanding and unyielding pressure, which is the most difficult yet essential feature of psychotherapeutic management to teach the younger medical officers. Its successful accomplishment springs from correct appraisal of the causes of breakdown.

The most valuable single factor in the management of head injury is undoubtedly that which might be called prophylactic psychotherapy. This is the affair of the ordinary physician or medical offiicer. Optimism is often said to be the essence of psychotherapy. Whereas this is surely true of nervous conditions in general, its wholesale application to head injuries is nearly as detrimental as undue pessimism. There is nothing more infuriating and discouraging than to be expected to achieve what is not possible. The successful management of head injuries therefore requires knowledge of what might reasonably be expected of the patient. To get a moderately severe head case up in the third week after injury brings the same troublesome sequelae as keeping a very mild case lying flat for four weeks. The first is discouraged by failure and takes a long time to get over the reaction; the second is convinced that some vital damge has occurred and will be anxiously on the *qui vive* for catastrophe for a long time afterward. The nature of the man and the severity of the injury must be taken into account. Insomnia and anxiety indicate underlying emotional tension. Regular discussion of difficulties, reassurance and encouragement to further performance are the keynotes of success. They are not time consuming, and the right kind of discussion for five minutes each day can accomplish more in the early stages than whole days of psycho-

therapy can correct at a later date. One of the commonest causes of relapse is the attitude taken by relatives, the family doctor or the medical officer of a convalescent home. Time and again, a patient who has progressed favorably has been allowed home to convalesce, and the first time he has had a mild headache has been taken by anxious relatives to the family doctor, who, hearing that he has had a head injury, insists on complete and prolonged rest in bed (instead of planned activity and less excitement). This strong suggestion is too much for many patients, who relapse forthwith. For this reason, a brief spell of active duty before a leave of absence is usually advised.

Conclusions

In conclusion, it is emphasized that the peculiar mixture of trauma and emotional shock that constitutes all war (and most civil) head injuries retains traces of both features throughout the convalescent period. Too frequently, emphasis is laid wholly on either structural damage or psychoneurotic state, with consequent failure to achieve the best results from treatment of both. Although particularly evident to the trained neurologist by reason of his familiarity with both functional and organic nervous disorders, the proportions of the mixture should be evident to anyone who takes time to sum up the pretraumatic nervous constitution and personality, the severity of the general brain injury, the residual intellectual and physical state, and the nature and degree of persistent anxiety. It is from lack of full appreciation of such factors that disappointment in the results of treatment arises. It is maintained that intensive effort along these lines not only will conserve and rapidly restore to duty officers and men the services can ill afford to lose but also will substantially reduce the great bulk of persistent disability that became a national calamity after at least one previous war.

The diagnostic and prognostic limitations of abnormalities in air encephalograms and electroencephalograms are discussed, and the

important conclusion reached that some persistent defects in these are compatible with recovery without any disability. It is maintained that the key to most organic disability is defective intellectual function. No single test will alone demonstrate a hopeless prognosis.

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REHABILITATION OF HEAD INJURIES

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The need of adequate facilities for the rehabilitation of patients who have sustained a cranio-cerebral injury is very great, and that attention has recently been focused upon this subject is one of the more fortunate aspects of the present world war. The reasons for this consideration are mainly twofold: first, that large numbers of such injuries have been collected in various centres and, secondly, that the majority of these patients are prospective candidates for some form of government compensation or pension. Much trouble has accrued in the past from this type of injury, although it has attracted possibly less than its fair share of notice from the medical profession as a whole. The many insurance firms, however, are well aware of the existence of the sequelæ of head injuries and should welcome the development of this form of rehabilitation as, when properly carried out, it must inevitably produce an appreciable fall in the incidence of post-traumatic states of one sort or another.

Conditions of Treatment of Cranio-Cerebral Injuries

At a time such as the present, when so many cases of head injury are collected together in the special head centres, it is all too easy, for the neurological surgeon at least, to feel that all head injuries should be admitted to, and treated in, a department for this type of injury alone. It is true that the patient will experience many advantages by being so admitted. He will be in the hands of those who are familiar with the many difficulties associated with the restless, irritable, violent stage which so often follows the more severe type of head injury, those who realize the importance of the quiet approach, the simple, almost childish, explanations, the careful atten-

tion to small detail and the illimitable patience, needed in caring for those with cranio-cerebral injuries.

In such specialized centres those facilities are available without which no modern neurosurgeon is able to carry out his work effectively. At the same time there is available the secretarial staff without whose aid the meticulous records cannot be made, and it is upon these records that the final assessment of the individual case depends. Although the above facts suggest strongly that head injuries should invariably be treated in such special centres, it must be remembered that there is one serious drawback to a herding together of cases of cranio-cerebral injury. This defect must always be borne in mind, for it is of great and often serious importance. The ambulant and recovering patient is thrown into the society, almost entirely, of those who have sustained similar or worse injuries of the same nature as his own. If he be a suggestible person he may readily develop symptoms of headache, unsteadiness of gait, subjective vertigo and the like, as a result of such close contact with others genuinely suffering from post-traumatic states. There is no doubt in many minds that this condition of affairs is true, and it is a serious defect in what would otherwise be a most satisfactory system.

In the peaceful future it is to be hoped that such close association of similarly injured patients may be at least diluted by their admission to general accident wards in a hospital where there is also available the team of neurologist, neuro-surgeon, psychiatrist, almoner, occupational therapist and trained secretarial staff, who will also be employed in the same institution in a general neuro-psychiatric department. Thus only can the desired end be achieved and the patient with the cranio-cerebral injury receive the most adequate care and attention.

Personnel

It must not be forgotten that rehabilitation begins with return to consciousness on the part of the patient. In the early hours and days of recovery much may be done towards achieving the best end-

result, and to this purpose there must be a team of individuals at work together, each with his or her own field, and each ready to play the appropriate part at the correct moment.

NURSES. — Nurses should be specially selected, at any rate as regards the senior members of the staff, for it is upon them that much hard work will fall and theirs is often a thankless task of considerable difficulty, as all who have had experience of the acutely irritated head injury will agree. "Intelligent anticipation" should be their watchword. One example alone of such an attitude will suffice: all are familiar with the disorientated head injury patient, irritable and restless and determined to get out of bed. Few perhaps realize that the apparently insane desire to leave bed is for the sole purpose of evacuating the bladder or bowel. The desire to go to the appropriate place is strongly imbued and apparently persists despite gross cranio-cerebral disturbance. The provision of the bed-pan or urinal at the psychological moment does much to prevent such unfortunate crises, and is a good example of what has been called above "intelligent anticipation." Nurses in such departments should have special lectures on the care of the head injured from the departmental staff concerned, to enable them to cope with their many difficulties.

PORTERS OR MALE NURSES. — Such persons are often required and should realize that "main force" is the last of their requirements. They may in the end be required to prevent violence on the part of the patient, but they should use physical restraint in as gentle and reasonable a manner as possible. Adequate treatment with drugs make their need an occasional one only.

MASSEURS. — The masseur is a most valuable member of the necessary team from the early days of recovery until the end of the period of stay in hospital. In the milder cases their services may not be required, but in any patient whose stay in bed is likely to be a matter of weeks rather than of days the masseur can do much to keep tone and use in the lower extremities, and to a great extent lessen that feeling of weakness which besets each patient when he first rises from his bed. In the more severe cases, in which there is possibly paralysis of an extremity, the masseur has a vital part to

play in the prevention of contractures, the retention of full mobility at all joints and the maintenance and encouragement of power in the affected parts. Later, in the ambulant stage, first light and then more vigorous physical exercises are of the utmost value in promoting that steady but graduated return to full normal activity.

Occupational Therapist. — Although occupational therapy plays a part in the rehabilitation of patients with head injuries, it is perhaps not as important a part as that played in other branches of neurological surgery. During the earlier period of recovery, while the patient is still confined to bed, some forms of occupational work may be given, compatible with the degree of mental ability of the patient, mainly with the idea of stimulating interest and occupying time. Such pastimes should be carefully chosen with regard to the personality concerned and should lie always just within the powers of the individual without requiring too much effort at concentration. It is all too easy for these patients to lose interest from excessive effort being required of them and, if this takes place, harm rather than good has been done.

In the more seriously injured, when permanent physical or mental damage is likely to result, the occupational therapist has more scope for his work: his will be the lot of designing therapy to bring back the fullest possible use to the affected part, to aid in the assessment of permanent mental damage, and eventually to fit the physically defective convalescent for a new occupation or trade. It is long and arduous work but worthy of great endeavour. Its use is but beginning to be fully appreciated in this country and should make great strides in popularity when once its value is fully understood.

The Almoner. — Once again this much overworked profession must be called in to assist. The home circumstances, the financial position at the moment and for the future, the question of compensation, the return to the original work or to a new trade, the continuance of physiotherapy or occupational therapy, and the place of final convalescence, require the urgent attention, professional experience and understanding of the fully qualified almoner. What has been written above, and much more also, is true of most

branches of medicine and no less so of the treatment and after-care of cranio-cerebral injuries.

MEDICAL STAFF. — There can be little doubt that the cranio-cerebral injury falls within the province of the neurosurgeon and the neurologist, for, although the treatment is seldom actively surgical, the problems which frequently arise require that attention to detail and that understanding of the physiological principles of the working of the central nervous system in which the modern neurologist and neurosurgeon are trained over a period of many years. It would be desirable that the more practical application of this knowledge be taught to the coming generations of medical students, for the treatment of many cranio-cerebral injuries is within the scope of most medical men once the essential principles are understood and the danger signals appreciated.

A great deal of care and attention is required of those in charge of head injuries, but it is important that this attention should not be too openly exhibited to the patient. Thorough examination of the nervous system at appropriate times is, of course, essential, but it is equally necessary that the physician should remain as much as possible in the background, making those vital assessments of diagnosis and prognosis and directing the activities of the patients through the media of his ancillary services. Too much contact between the medical director and the individual patient may readily convince the latter that his injury is of a more serious nature than he would otherwise be inclined to believe. It is better, on the whole, that such contact be limited to essentials.

So much may be said for those into whose hands much of the present and, it is to be hoped, the future treatment of cranio-cerebral injuries falls.

The Immediate Period of Recovery

Rehabilitation begins at this point, and this should be impressed upon the nurse who has to care for each patient day by day. Unremitting care and patience in the early stages, cheerful encouragement a little later when the recovering brain is in a state to benefit by it,

tempered occasionally, when the need arises, by a degree of firmness.

The patient should from the first be led to believe that he will recover satisfactorily, for this is true of by far the great majority; and the minority who will retain some permanent defect must have their minds led into the most suitable channel. If it be a permanent physical defect from which they are to suffer, their mental outlook should receive the major attention, but if it is to be permanent lack of concentration, or some similar mental defect, then stress should be laid upon their physical well-being. Much of this necessarily devolves upon the nurse and special care should be devoted to her training so that she is well fitted for her task.

One fact upon which the patient will inevitably concentrate is the nature of the treatment he receives during this early period of recovery, and a word should be said regarding lumbar puncture which, in many neurosurgical units, forms an essential part of the diagnosis and treatment of acute head injuries. Lumbar puncture can be, and is in skilled hands, an absolutely painless procedure and it is essential that this be so. When thus carried out in a patient with a raised intracranial pressure and associated headache, the procedure affords almost immediate relief of headache and is consequently regarded with favour by the patient. Conversely, if the injured are to be subjected to an agonizing process, which it may well be in careless or untrained hands, at intervals of a few hours or days, that patient will come to dread the next appearance of the medical attendant, and will eventually be convinced that he has been most gravely injured if his condition necessitates so painful a mode of treatment.

The Second Stage

Once free of headache, nausea, vomiting or giddiness, which in most cases is only a few days from the receipt of injury, the patient is ready for the next stage, and here the masseur and occupational therapist are required. Boredom is a fatal thing in the case of the

recovering head injury and must be studiously avoided. Although it is bad to overwork the injured brain it is good to exercise it gently, and from the beginning of this stage the patient should lead an organized life designed to make each day pass as pleasantly as possible. The normal ward routine is an excellent beginning, for there are already stated times for many activities. In addition to this, each patient should have something arranged for each period of the day: it may be merely massage to the legs, or to some other part of the body; it may be some simple form of occupational therapy, even the folding of bandages or swabs will be of assistance, but such pastimes should be undertaken at a certain time and continued for a definite period which must end before the patient either loses interest or becomes unduly tired. A gradual increase in the period of such occupations, as well as a change to more advanced subject matter, may then be made coincident with the increasing recovery of the individual concerned.

The Ambulant Phase

When the patient begins to leave his bed, which may be a matter of a few days or many weeks, depending upon the nature of the injury, the need for an organized time-table throughout the day becomes more apparent. Every effort should be made to stop the aimless wandering about the ward, the hospital or its grounds by recovering patients.

After the first few days of regaining their feet, light physical exercise may well be permitted and encouraged, gradually increasing both in extent and in vigour as the patient tolerates it. Definite duties should be assigned to such convalescents, either in the ward or in some other part of the building or hospital grounds. Due precaution must be taken at this period that no untoward symptoms occur and that the patient does not become excessively tired.

At this point in recovery it is important that a room be provided where the individual may enjoy peace and quiet. The noise and bustle of a large or busy ward often induce a restlessness or irritabil-

ity in recovering head injuries which is readily understandable, and which may often be allayed by a period of rest and quiet. Patients should not, however, be allowed to remain for long periods in such reading or rest rooms, for they must be slowly attuned to the normal activities of the hospital and the happy medium must be sought for in each such case.

The Final Hospital Period

By this time the patient is free from symptoms and ready for discharge from hospital, or has reached a stage when further hospitalization is undesirable. Some assessment of permanent or prolonged disability, if any, must now be made and provision for the future considered. At this point consultation between almoner and medical officer is necessary. If the patient has made a full recovery, all that is necessary is a short holiday before return to normal life; and such holiday will be arranged by the almoner through available channels according to the person in question.

If permanent physical or mental disability remains, the occupational therapist may also be called in consultation to give views as to the present and probable future capabilities of the patient, after which the almoner will arrange either institutional care in severe cases, the continuation of physiotherapy or occupational therapy in those in whom further slow progress may be expected, or the taking up of new work of a less arduous nature in those who may be capable of it.

The problem is frequently one of great difficulty but is not insoluble, and it is surprising how much may be done with willing and enthusiastic colleagues.

The Individual Patient

Each patient must be considered individually both during treatment and at the time of assessment and discharge from hospital. To the professional man or woman, whose profession or occupation is a matter of real interest as well as a means of livelihood, much

of what has been written above will be redundant. Such persons almost invariably recover well, cooperate in the treatment of their case and return rapidly to their previous existence. Should they suffer occasional headaches or experience difficulty in concentrating upon their professional work, they voluntarily modify their lives in compensation until they find that they have reached normality once again.

With the heavy labourer the opposite is all too often the case. The work of such people is seldom interesting and is carried out only as a means of earning a living for the family. The question of compensation looms largely in a mind without much insight or elasticity. The distorted facts surrounding the unremembered injury, gained in conversation with relatives or friends, are firmly impressed upon the mind and become more indelibly imprinted with each week that passes before final compensation is achieved. The post-traumatic syndrome is all too readily established in such a mind and may readily become intractable.

Between these two extremes lie many variations. The wider the outlook, the broader the interests of the individual, the less likely are subjective sequelæ to develop, but in the smaller and less flexible mind the injury, and the compensation which may follow, may well flourish like weeds in the war-time gardener's allotment.

REHABILITATION AFTER HEAD INJURIES

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Most of the difficulties which confront the doctor in the management of patients convalescent from head injury arise from incomplete investigation. It is not sufficiently realized that a case of head injury presents entirely different problems at different intervals of time after the accident. In the acute stage the main question at issue is: "Will the patient live or die?" He is often deeply unconscious, with perhaps scalp wounds and other injuries requiring operation and blood transfusion. When, after critical hours or days and considerable work on the part of the doctor and nursing staff, the patient emerges from danger, it might be expected that all concerned could indulge in mutual congratulation and rest. But it is precisely at this stage that new problems arise. Has the patient suffered permanent brain damage? Will he be able to resume his former work, and if so how soon? What should he do in the meantime?

Need for Systematic Investigation

The case at this stage is virtually a new case requiring systematic investigation, not only of the nervous system and of the intellectual functions, but also of the patient's past, social and family histories. Patients react very differently to head injuries of similar intensity, and the differences depend to a large extent upon the type of individual and on his powers of adjustment. That investigation along these lines is absolutely essential is illustrated by a recital of some typical examples of head injury, which also serve to present some of the problems of after-care.

CASE 1.—*Motor-cycle accident: mild head injury: return to work after inadequate convalescence: relapse.*

A soldier, aged 28, (M.H. 2655), was admitted to a Military Hospital

for Head Injuries on account of headaches after a head injury sustained while motor-cycling four months before. He had worn a crash helmet at the time of the accident, and the head injury had been a relatively mild one. The total duration of amnesia was four hours, his skull had not been fractured, and after two days he felt perfectly well. However, he was kept in bed for seventeen days, and then, after being up for only two days, was sent back to his unit. During the train journey a frontal headache developed and he became anxious about the possibility of his brain having been damaged by the accident. For the next three months he was given light employment with his unit, but headaches continued and his work was unsatisfactory; the medical officer therefore sent him into hospital again. His family and past history were excellent except that he had had a mild concussion one year before. He was a keen, ambitious type of man, with preoccupations, though somewhat worried by the persistence of headaches. Examination of the nervous system showed no abnormality. After explanation, reassurance, and graduated exercise, he returned to his unit and subsequent reports of his work were satisfactory.

In the above case the primary mistake was to allow the patient to take a train journey three weeks after his accident and without preliminary physical preparations for the journey. This obvious measure is far too often neglected, with the result that headache, dizziness, or a feeling of faintness develops in the train, and the patient begins to wonder whether he has recovered so completely as the doctors asseverate. The mishandling of the patient often arises from the belief that the way to prevent post-traumatic headaches is to keep all patients who have had concussion flat in bed for a period of two to three weeks after injury. Cases like the one described above show the fallacy of this belief. There is no certain way of preventing post-traumatic headaches, but what we can do is to condition the patient to them by graded physical activity, combined with explanation and the use of analgesic drugs when required. It is better policy to begin to get the patient out of bed about a week after he has recovered full consciousness, and then, without curtailing the time spent in hospital, to subject him to a graduated regime of physical hardening. This can be done without increasing the frequency of post-traumatic headaches. Before the patient goes on a train journey he should have had a course of physical exercises and should have been tested by visits to the shops or cinema and by other normal activities. If any of these is followed by headache he can be given temporary rest,

analgesic drugs and explanation that although a certain amount of headache is inevitable after head injury it does not signify permanent brain damage. And the patient can thus learn to bear such headaches as he may have with fortitude and without alarm.

CASE 2.—*Head injury followed by impairment of concentration: symptoms aggravated by excess of alcohol.*

A stockbroker, aged 24, (No. 2589), fell asleep while driving a car at night; the car ran into a sign-post, and he came to himself among the debris. After a few days in bed he returned to work, but he immediately noticed a defect of concentration and of memory, and this persisted. A year later he sought the advice of several doctors. Examination showed nothing abnormal in the nervous system, but his past record indicated that he was a little unstable, and there was a family history of alcoholic excess. He was reassured and advised to continue at his work. Three years later, in response to "follow-up" enquiries, he reported that he was quite well, and confessed that at the time of his head injury and immediately after it he was "sowing wild oats," drinking an excess of alcohol and seldom in bed before 2 a.m. He had since reformed and was living a regular life.

In this case the problem of rehabilitation was quite a simple one, which could easily have been solved by other means than good luck if the individual as well as his nervous system had been systematically studied at the time when he presented himself for treatment. In young men particularly it is important to enquire thoroughly into the habits of living, for they are apt to experiment in surprising ways before they finally settle down.

The following is an example of perpetuation of symptoms owing to financial and domestic anxieties.

CASE 3.—*Head injury: probable fractured base of skull: psychoneurosis.*

A concrete worker, aged 23, (M.H. 175), fell ten feet on to concrete on February 3, 1940, striking his head and fracturing his left clavicle. He was unconscious for seven hours and bled from the left ear for twenty-four hours. On recovery of consciousness he suffered from double vision and frontal headaches, and these symptoms persisted. He was kept in bed for five weeks and thereafter attended hospital as an out-patient. When walking he at first felt extremely weak, and he had several attacks of vertigo. In July, 1940, he returned to light work, although still suffering from headache and diplopia. In the following month he was called up for military service. He reported sick and was excused duties, and then he was transferred to a Military Hospital for Head Injuries. On examination (August, 1940), the only neurological

signs were weakness of abduction of the left eyeball, and diplopia on looking to the left and to a less extent on looking downwards; slight nystagmus to the left; slight increase of the left ankle jerk; and an extensor plantar response on the left side.

The past and family histories were good. He had always been apt to worry over little things and regarded himself as "a bit on the nervy side." He was happily married and at the time of his accident had a good job. Whilst in hospital after the accident he began to worry over his financial situation; he was receiving only thirty shillings a week as compensation, and when he had paid his rent, his weekly instalment for hire-purchase and his insurance there was not enough money for food, even when he got an additional seven shillings and sixpence from relief sources. His wife was about to have her second child. She had always "had good money before." When he started work again he was still suffering from headaches, but they were better when he was working. He attributed them to his nervous condition. When it was explained to him that there was a moratorium in connection with hire-purchases, and after his wife had come safely through her confinement, he soon lost his headaches. He was given graduated exercise, gymnastics, and occupational therapy. The double vision disappeared, and he stated that he felt his normal self again. He returned to his unit in October, 1940, and seven months later his medical officer wrote that during the intervening period he had reported sick once only, for headache, and that he was performing full duty efficiently and willingly.

The basis of this man's persistent symptoms was a genuine anxiety over his financial and domestic affairs, and the symptoms cleared up promptly on reassurance. In such cases the main point is to elicit the worries and anxieties by systematic inquiry into the social history and background of the patient.

CASE 4.—*Head injury complicated by depression*

A lady, aged 34, (No. 5698), received a head injury while riding in the back seat of a motor car. She was unconscious for about an hour and a half, and had a black eye on the right side. She remained in bed for a week, during which time she was nervous, excitable, sleeping badly, and complaining of headaches. But these symptoms improved, and after being up for a few days she went for a quiet holiday, returning to work twenty-four days after the accident. During her holiday she suffered from palpitation when walking short distances. At work she began to suffer again from headache (as if her head were compressed in a vice), nausea, and inability to concentrate, and she felt depressed and tearful. At the end of each day she felt very tired and cold. She slept badly. After a few days her doctor put her off work again. She had never been seriously ill before and she gave a good family history, but inquiry from others showed that she was of a

mercurial, worrying type, as were others of her family. On examination, thirty-three days after the injury, there were no abnormal signs in her nervous system. Examination by X-ray showed a tiny fissured fracture in the right frontal region.

The diagnosis was that of slight head injury followed by a mild depression. She was sent away for a further three weeks' holiday with graduated exercise. During that time she felt depressed, melancholy, and at times rather desperate. She slept badly and was still easily exhausted after physical exercise. She gradually improved and returned to work twelve weeks after the injury, feeling quite herself again, although still suffering occasionally from headaches, as well as from mild vertiginous sensations on stooping. Two months later she reported herself as quite recovered.

In this case a mild head injury was complicated, after a too early return to work, by the onset of an attack of depression in an over-conscientious person predisposed to such attacks. The patient occupied an important position, and her employers treated her with consideration and so no harm was done. It is possible, however, that if in the first instance her case had been systematically investigated, convalescence might have been better regulated and she might have been able to return to regular work sooner. But in predisposed patients attacks of depression are not at all uncommon after head injury, and in such cases the period required for rehabilitation is increased beyond the usual time.

Difficult Problems of Rehabilitation

The cases so far described presented relatively simple problems of rehabilitation. The following is a much more difficult type of case, in which impaired memory and loss of learning capacity, combined with some lack of insight, demanded a down-grading of occupation in an able young man of obsessional type who was reluctant to give up his earlier ambitions.

CASE 5.—*Head injury followed by dysphasia and right hemiparesis, gradually recovering: impaired memory and lack of insight: mild traumatic epilepsy.*

The patient, (No. 2479), was a young man of 26. One of his uncles died of epilepsy in childhood, and his mother's family showed a cyclothymic tendency. The patient himself was a brilliant student of the over-conscientious, pedantic type. After leaving school he worked for two years in a factory and then took a degree in mechanical engineering. After that he undertook

investigations in connection with psychology and was regarded as a most promising research worker. In April, 1935, he fell while rock-climbing and received a compound fracture of the right parietal region with diastasis of the coronal suture, and was unconscious for several days. On recovery he was found to have mild nominal dysphasia and dyslexia, slight weakness of the right side of the face, and weakness and sensory loss of the right upper limb. The resulting disabilities were never great after the acute stage of the illness, and less than two years later only traces of them could be detected on routine examination. In October, 1935 (six months after the accident), he had an epileptic fit, another in January, 1936, a third in March, 1937, and then no more during the ensuing five years, during which time he was on regular anti-convulsant treatment.

Before the accident he was an eager, intelligent young man of cheerful disposition; after it he assumed a rather frivolous manner and had at times outbursts of temper and periods of mild depression. He had at first difficulty in finding his way about familiar parts of London, and he was apt to be forgetful. Whereas before he had been a good mechanic he now had difficulty in doing relatively simple jobs. However, these defects did not appear to be severe, and as he was continuing to show steady improvement, he was allowed, one year after the accident, to have his desire and take up research work again. He proved slow, forgetful and inaccurate, and was quite unable to approach the standard of his former work. His third fit led to his being given six months' holiday, during which he undertook to build a boat, but left it unfinished. At this time he was recommended to take up a simpler occupation, such as cabinet-making, but he refused to accept the fact that his mental powers were no longer as good as they had been, and he returned to his researches. Six months later he lost his position. In October, 1938, two and a half years after the accident, he took up work in the same factory and at the same wage at which he had been employed after leaving school. Here he was evidently given the opportunity to improve the processes of manufacture, and he spent a good deal of his time trying to invent new ways of doing things, but without success. In March, 1940, he was asked to seek a new job.

Formal tests at this time by Professor Koffka and Mr. Oldfield showed that although his intelligence still remained superior there was a slight unreliability and lack of precision about his higher mental processes, particularly those concerned with verbal meanings and constructions. He still resisted medical advice to seek work of a routine character, and he got employment in aircraft production, which he lost after six months. At this time Dr. Erich Guttmann found that he was still very intelligent, but that his learning curve (Rey-Davis) was very bad. In speech he had slight difficulty in making choice of words, partly due to the fact that he was an over-conscientious, over-exact type. Dr. Guttmann considered that this "obsessional" character, more than his difficulties of memory and intellect, was responsible for his failure. There-

after, doubtless helped by the circumstances of the war, he accepted medical advice and undertook, first, agricultural work, which he did well, and then work as a fitter of machine tools. At the latter he soon found that his manual skill was returning and that his understanding and confidence were improving. After three months he was given a rise of wages. He became less preoccupied with his ambitions and more interested in current events and in other people. In January, 1942, his parents, shrewd observers, stated: "He is a much more normal person now and accepts his loss of memory with philosophy and good temper. Perhaps also his memory is a little better."

After a severe head injury this intelligent, obsessional type of young man retained his ambition to pursue work which was no longer within his intellectual capacity. In the first two years after his injury, while he was still continuing to show improvement, he was allowed to have his way and to return to his old employment. When he failed, the correct advice was given as to the type of occupation he should undertake, but in retrospect it is doubtful whether it was presented as firmly as the patient's personality required that it should be. It was not until six years had elapsed from the time of his injury, and then partly due to the extraneous circumstances of the war situation, that he went into the right type of routine employment, in which his adjustment to his disability improved and he also began to show improvement in his intellectual capacity. This type of patient is much more difficult to rehabilitate than those in whom a gross permanent disability makes it clear from the outset that change of occupation is inevitable. Skilled psychological investigation is essential, and doubtless great assistance could be obtained from expert observation of such a patient in a rehabilitation centre, if this were possible.

Cooperation of Employers

On return of the patient to work it is often necessary to obtain the cooperation of the employers, as in the following case.

CASE 6.—*Head injury: injury to left optic nerve.*

A man, aged 40, (R.I. 18618), was knocked down by a car in the blackout. Amnesia lasted for four days, and during this time he was disorientated and confused. He had a fracture of the left side of the frontal bone extending into the left optic canal. Vision in the left eye was reduced to counting

fingers, and the left optic disc gradually became atrophic. Smell was lost at the left nostril, and for a few weeks he suffered from excessive thirst and from periodic headaches. At routine "follow-up" examination four months after the injury he stated that he was having headaches. Inquiries soon disclosed a cause, for it appeared that when he went to take up once more his work as a sawyer, at which he had been employed for eleven years, his employers demurred, on the ground that he had lost stereoscopic vision. He was referred to Miss Ida Mann, who found that he had readjusted his judgment of distance well and that in all probability he would be able to carry out his previous work. Representations were made to his general practitioner, and he resumed his former occupation satisfactorily.

Methods of Rehabilitation

Very little headway can be made by the routine application of physical exercises and occupational therapy without thorough assessment both of the degree of brain damage and of the type of patient. After investigation has been made the next step is to reassure the patient, as one can reasonably do in the great majority of cases, that there is little likelihood of residual disability. If the patient is still confused, reassurances may have to be repeated on several occasions, and the relations must also be reassured at the same time. After the patient has returned to consciousness, the process of getting up should not be long delayed and should soon be followed by graduated physical activities. Handicraft is useful at this stage. Later, occupational therapy may be necessary, especially for patients in the Services, who must be rendered fit for full duty before they can be returned to their units. In patients in whom the degree of permanent disability from hemiparesis and other signs is likely to interfere with the resumption of former occupations, vocational training is required. Among the severely disabled, speech therapy and other mental training may be necessary. In a considerable number of cases of both mild and severe injuries, visual symptoms call for refraction and other ophthalmological investigation and treatment. Every effort should be made to encourage the patient to adjust himself to the effects of his injury, and this usually involves an intimate study on common-sense lines of the man, his background, his mood and his anxieties. In a certain number of cases the help of expert psychol-

ogists may be required. In the final stages it is important that contact should be made with the man's employers or works doctor, and in civil life for this purpose and for follow-up studies the assistance of a social worker is invaluable. The process of rehabilitation should be continued into the factory. In many cases, particularly in the later stages of convalescence and on resumption of work, headaches and attacks of dizziness may be troublesome symptoms. While these probably have an organic basis they are usually not insupportable, and they respond quickly to symptomatic treatment if the patient is assisted to make a satisfactory adjustment on the psychological side.

Causes of Failure

Causes of breakdowns have been illustrated in the foregoing case reports. *Returning to work too early* is one of the common ones. In the early stages of convalescence the patient may lack insight or may be pathologically restless. In these circumstances, and especially if he is in a position of relative independence and importance, he may do everything in his power to get back to work, even to the extent of disregarding the advice of his doctor. The result may be a breakdown, although often this can be avoided by explaining the position to the patient's wife, his employers or his colleagues. Some months later, with the return of insight, such a patient will often state that he now realizes hat he was not really fit at the time when he insisted on returning to work. *Physical softness* on return to the outside world is another cause of breakdown, particularly in the Services (Case 1). *Unrelieved anxieties* constitute a powerful deterrent to recovery (Case 3), and attacks of *depression* have a similar effect (Case 4). *Unsuitable occupation* is another cause which may interfere with satisfactory return to full work, particularly in the Services. The more severe causes of failure include *loss of intellectual capacity, epilepsy,* and disabilities resulting from *gross brain damage* such as hemiplegia, aphasia, blindness and so forth. In this group of cases the patient will not be able to return to his previous occupation, but, with adequate facilities for vocational training under expert observation, much can be done to make these patients into useful

members of society and at the same time to regain for them their self-respect.

Rehabilitation in General

If we look back on what has already been achieved it is clear that the impetus towards adequate rehabilitation has come to a large extent from the specialists. The foremost workers in this field have been those especially concerned with blindness, mental disease, pulmonary tuberculosis, fractures of limbs or other orthopædic disabilities. This is a natural development: it is only by the segregation of patients for special study that the detailed problems of after-care of each type of malady become apparent. For example, a group of peripheral nerve injuries is collected, and before long the surgeon in charge is devising special splints to assist in the recovery of particular movements. With haphazard selection of patients for rehabilitation the more detailed problems of after-care, which vary considerably in different types of case, may remain undisclosed. This does not mean that centres for rehabilitation must necessarily be limited to one or other special type of malady. Indeed the amenities desirable in a centre are of such a wide range that it is highly desirable that they should be shared by as many types of patient as possible. There is no serious reason why patients convalescent from limb fractures, injuries of the head, chest, or peripheral nerves should not use the same gymnasium, sports ground, and so on. The positive advantages may, indeed, prove to be considerable. Although little attention has so far been directed towards the psychological disturbances following limb injuries, there are some grounds for the belief that the problems of adjustment to somatic injury are much the same as those illustrated by the head injury cases of this article. Within the centre a certain amount of segregation may often be desirable, and continued supervision by the specialists who have treated the patient in the acute phase of his injury will usually be necessary. War-time provides a great opportunity for intensive study of certain types of disability and of the appropriate measures of rehabilitation. The case for continuous supervision of the convales-

cent fighting man until he is fit to return to duty is clearly established, and there is no difficulty in sending him to a rehabilitation centre. With civilians it is otherwise. Once out of bed and able to move about they are discharged from hospital to their homes, and in their convalescence they are usually left to their own devices and to those of their relatives, aided by such encouragement and supervision as their general practitioner can give them. With this haphazard procedure the responsibility for getting well rests mainly on the individual patient. It is highly desirable that nothing should be done to take this responsibility from the patient, for the final effort to return and to remain at work can only be made by the patient himself. But there is little doubt that closer supervision of the civilian convalescent would result in great saving of man-power. To what extent this would require that the patient should spend his convalescence in a special rehabilitation centre rather than in his own environment remains to be worked out for each individual type of case. As far as head injuries among civilians are concerned our experience to date suggests that treatment at a resident centre would only be required for the more serious and difficult cases. The remainder of the patients could be supervised at gradually lengthening intervals at the out-patient department of a head centre.

Reference

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SPEECH DISORDERS AND THEIR TREATMENT

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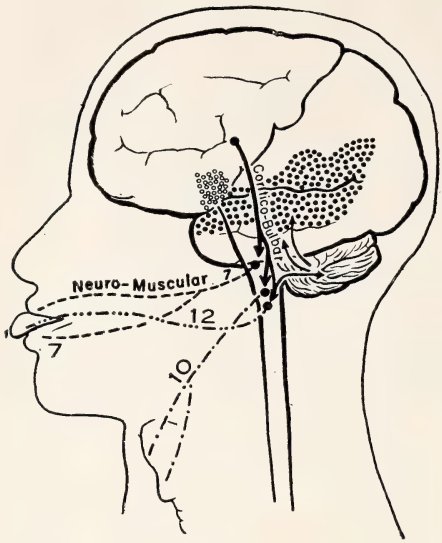
In order to understand speech disorders, one must know something of the development of speech in man and his ancestors. In phylogeny there is evident a close relationship between the development of binocular vision, manual skill, and finally a leading hand and leading cerebral hemisphere. When man's shrew-like ancestors took to trees and left behind them quadrupedal locomotion, their fore-limbs were emancipated to become hands, and the possibility of dexterity developed. Other vibrates specialize and reach narrow superiority by unique development of one type of sense organ. Man excels because of lack of specialization. His specialty is a leading hemisphere, evenly developed in the reception and elaboration of all types of sensory impression. It is this even development that allows for association betwen the different sensory receiving stations; and it is the development of the mechanism of association that has made intellectual behavior possible. The dominance of the left hemisphere is marked in right-handed people, who constitute about 75 per cent of the population. The functions are probably not confined to the left hemisphere; the dominance is relative. Recent studies have shown that even speech is subserved in a rudimentary way in the right hemisphere of right-handed persons. With a leading hemisphere in which there is a predominant centering of manual skill (eupraxia), symbolic understanding (eugnosia), and language, there is a great need of many associative tracts. The function of language needs both eupraxia and eugnosia, in fact, each needs the other two for effective behavior. Nevertheless it can be taken as a proposition that language is the most highly integrated of man's functions.[1, 2, 3]

In the central nervous system of man, speech is integrated at five



V—Social, Personal, Emotional, etc.

IV—Symbolic, Inter-personal

III—Cerebellar

II—Cortico-bulbar

I—Neuro-muscular

FIG. 1

important levels; these are not exact, and to some extent overlap but for purposes of exposition Fig. 1 shows the main centers involved. The broken lines show the lowest level, the neuron from a nucleus in the medulla (seventh, tenth or twelfth) to a peripheral organ of speech, lips, tongue or larynx. This is level I, the neuromuscular neurons and the final common paths over which all nerve impulses concerned with speech must pass. Level II is the neuron arising in the motor cortex and ending in the medulla around the bulbar nuclei (seventh, tenth and twelfth), its fibers pass down the corona radiata, through the internal capsule to the peduncles and medulla. This, too, is a common pathway for all the complex speech integrations of the higher levels. It is closely correlated for motor speech production with the cerebellar paths (Level III) which run up from the medulla to the cerebellar cortex, thence to cerebellar efferent nuclei and upward to mid-brain, thalamus and motor cortex. This makes a loop and supplies the mechanism of coördination so greatly needed in the control of speech. These three levels can be considered together as a rather straightforward motor mechanism.

Moving up to Level IV is a big step, for symbolization and meaning come in here. The anatomical localization is cortical with intricate association fibers between the different parts of the speech areas (dotted on cortex of Fig. 1). The circular stippling indicates the motor speech area (Broca), the black stipples show the auditory and visual areas of language functions and their subsidiaries. These areas are well developed in only one hemisphere, the "leading hemisphere," usually the left. The degre of dominance is important.

Fig. 2

Level II—Cortico-Bulbar

Common Lesions: Syphilis (G.P.I.)
Cerebral Arteriosclerosis

Clinical Results: Dysarthria, Weakness, Paresis or Partial Paralysis

Treatment: Antiluetic or none

Level V is the most highly integrated and least localizable. It is associated with the great association area of the frontal and parietal lobes. It brings in memories, individual life experiences and the impact of one person upon another including the varied and important emotional reactions expressed by glands, smooth muscle and skeletal muscle. The visceral expressions are mediated by the hypothalamus and the autonomic system; the overt behavior responses are expressed largely by skeletal muscles as behavior. Although both may *express* emotions, they are not the *sources* of emotion, which must be looked upon as largely cortical, individual and extremely complex.

Taking up each level in turn in regard to (a) common lesions, (b) clinical results of these lesions, and (c) treatment, one finds little of interest in level I. The lesions are usually the obvious developmental defects of the end organs treated by surgery, e.g., hare-lip and cleft palate. Tying down of the tongue by a short frenulum is emphasized by some but is actually a rarity. Trauma and neuritis may paralyze the nerves. Surgical anastomosis may be necessary. Poliomyelitis or more rare degenerative diseases may cause nuclear lesions and, hence, bulbar palsy. Treatment is unsatisfactory; excessive doses of vitamins may be tried.

At Level II the cortico-bulbar neurons are found to be frequently affected by syphilis, as in dementia paralytica ("G.P.I.") and by cortical softenings from arteriosclerosis. Other pathological processes, such as tumor or encephalitis lethargica, rarely damage these neurons in a selective way. The result of injury to the nerve cells of the motor area which innervate bulbar speech mechanism is weakness, partial paralysis. It is partial because the innervation is bilateral, neurons from one motor area going to the nuclei on both sides of the medulla, although, predominantly to the opposite side. The clinical symptom produced by this weakness is *dysarthria* or slurred speech. The classical example is the patient with "G.P.I." who cannot enunciate "Methodist episcopal" but says something like "Methyst epistople." The treatment of this sort of bad enunciation is unsatisfactory. Antiluetic treatment sometimes brings back paretics' poor speech. Usually little or nothing can be done. The slovenly speech of uneducated persons must be ruled out by repeated trials of different test phrases and attention to other clinical symptoms.

The third level (III in Fig. 1) is elaborated in Fig. 3 to show more details of the cerebellar coördinating mechanism. Nerve impulses from cells in the medulla enter the cerebellum over afferent tracts (A) bringing in proprioceptive information, data as to what the muscles are doing. This is spread through the cerebellar cortex by the plentiful association fibers. Impulses then leave the cortex of the cerebellum and go to dentate nucleus (D) whence

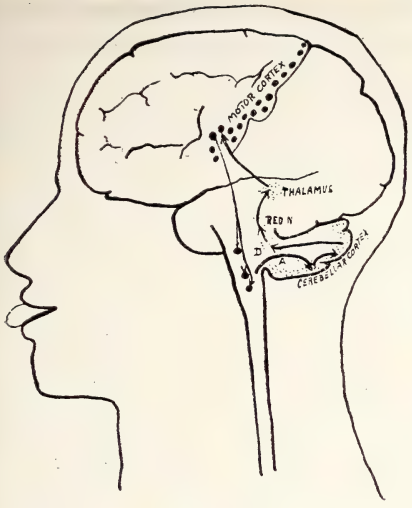


FIG. 3

LEVEL III—CEREBELLAR

Common Lesions: Multiple Sclerosis, Tumor, Encephalitis

Clinical Results: Incoordinate Speech, Scanning, Monotonous, Flat, Explosive, Staccato, etc.

Treatment: Possible Removal of Tumor; Usually None

they are relayed upward through the red nucleus to the thalamus. From here another neuron takes them to the motor cortex of the cerebrum where they have their effect on the motor impulses sent out from headquarters. Impulses from the roof nuclei of the cerebellum and from the red nucleus probably go directly down to brainstem and spinal centers to effect further motor control. Thus a loop or series of loops, is formed for making the delicate motor adjustments of speech all work together. The mechanism is for coördination or synergia.

Lesions anywhere along this pathway will cause trouble. The commonest to disrupt smooth speech are those of multiple sclerosis and epidemic encephalitis; tumors and softenings may also do the same. The clinical results are incoördination (asynergia) of speech, shown in the monotonous speech of Parkinson's disease (where the lesion is probably up near the thalamus), in the scanning speech of multiple sclerosis, and in the various explosive and staccato forms of speech found in encephalitis. Except for the rare removal of tumors, treatment is of no avail.

Level IV is divided in two parts (a) and (b) because (a) takes in the functions of the dominant, leading hemisphere, those func-

tions which are largely absent in the minor hemisphere, while (b) is the relationship between the leading and minor hemispheres. It deals with the degree of dominance of one over the other.

Level IVa (Fig. 4) is concerned with symbolism. Symbols must be sensed, recognized and understood as meaning something. The senses important to language are vision and hearing, each has three levels of integration. Visual reception is localized in the occipital pole and visual recognition in the stippled area just anterior to this. A lesion at the first level causes blindness; at the second, loss of recognition of perceived objects in other words, visual agnosia. A lesion farther forward, but still behind the angular gyrus (LEX Fig. 4) causes visual disorientation. The patient cannot remember the plan of a house, or he gets lost, although he may recognize the street or house he is seeing at the moment, because he cannot bring back series of pictures.

The auditory sense has three similar levels in the temporal lobe: auditory reception (AUD. REC., Fig. 4), auditory recognition of noises and auditory recognition of symbols (words). Since the innervation of the temporal lobe is bilateral, a single cerebral lesion

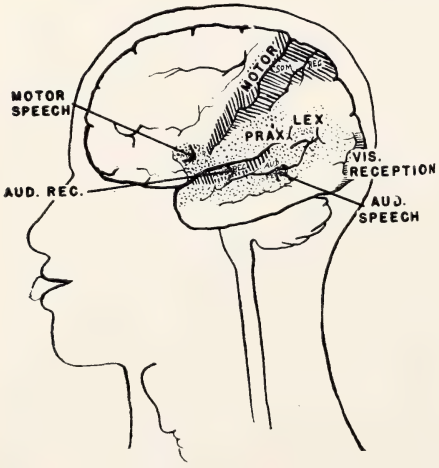


FIG. 4

LEVEL IVa—SYMBOLIC

Common Lesions: Arteriosclerotic Softening, Tumor and Trauma

Clinical Results: Deafness and Blindness, Apraxia and Motor Aphasia, Visual and Vis. Verbal Agnosia, Auditory and Aud. Verbal Agnosia, Agraphia, Amusia, Acalculia, etc., Semantic and Amnesic Aphasia

LEVEL IVb—LATERAL DOMINANCE

Common Lesion: Unknown, Inherited

Clinical Result: Slow Reading, Reversals, etc., Stammering, Ambidexterity

Treatment: Retraining by Reading, Speaking, Writing, etc. (Orton)

does not necessarily cause complete agnosia, and only bilateral lesions can cause deafness. Acoustic agnosia for sounds is not known to occur without some acoustic verbal agnosia, but in many cases of the latter the recognition for sounds is retained. Thus it is obvious that the acoustic mechanism is more variable and less unilaterally dominant than the visual mechanism. Recognition of learned symbols for words seen is in the angular gyrus, (LEX Fig. 4), and a lesion here causes visual verbal agnosia. The patient cannot read, he has "alexia" or "word blindness," as opposed to the 'word deafness" resulting from a lesion in the temporal lobe.

Motor dysphasia* is equally complex and depends on an understanding of the fact that no learned motor skill can be practiced without an ideational plan. This is a psychic elaboration necessary as a precursor to the carrying out of any complex motor act. This ideational planning is called eupraxia; the normal person knows how to do a thing quickly and almost automatically when requested. A defect of such performance in response to command is apraxia. It is a symptom of injury to the sensorimotor elaboration areas of the cortex, corresponding to agnosia from a lesion in the more strictly sensory area. In relation to most performances eupraxia is bilateral, the acts of one hand, for example, being planned in the opposite precentral and supramarginal gyri (between PRAX and LEX, Fig. 4). Lesions of these areas or their fiber connections may cause dyspraxia or apraxia.

Apraxia of the organs of speech (tongue, lips, larynx) causes "motor asphasia"; the patient loses the memory of how to make the movements to articulate words; he may know just what he wants to say, but he cannot get the plan of the word into his mind. A lesion of Broca's area (MOTOR SPEECH, Fig. 4) causes this symptom. As a rule only propositional speech is lost when the major motor speech area is injured. This is because the function of language is largely, but not entirely, concentrated in the leading hemisphere;a primitive sort of speech (emotional, expletive, habitual)

* Dysphasia, meaning disturbed language, is more accurate in most cases than aphasia, which means lack of language.

is subserved in the homologous areas of the minor hemisphere. Individual variation in relation to the degree of handedness is important.

The angular gyrus has the function of symbolic visual recognition, i.e., understanding letters and words by sight. Because words were first learned by hearing, however, this area cannot function if cut off from the temporal lobe. During the process of learning to read, words are sounded out or told to one. Thus the portion of the temporal lobe lying behind "Aud. Speech" (Fig. 4) is of great importance. A lesion here may cause as much loss of reading ability (alexia) as a lesion directly in the angular gyrus. Moreover, because language is learned by associating vision and hearing with objects and symbols, this area is particularly important, Nielsen[4] calls it "the language formation area." Take, for example, the case of objective nouns, the simplest and commonest words used. They are names, usually of objects seen. So memories must be stored in the posterior temporal lobe correlating both visual and auditory meanings. That this is true is shown by cases of temporal lobectomy in which the language formation area of the leading hemisphere is removed. The result is amnesic aphasia. The patient has lost the storage mechanism for nouns; his "naming center" is gone. When shown a pen, he uses circumlocution and may reply "It's to write with" but cannot say "pen."

If one takes these main symptoms (which are well explained physiologically), agnosia, motor aphasia and amnesic aphasia, and adds the obvious complications, it is seen that many special sorts of aphasia are possible. But by sticking to the principles laid down, these strange phenomena can largely be explained and localized. For example, one can hear music as well as words; therefore "amusia" is found. One can learn several languages and have marked aphasia in one but little in another. Symbols used for mathematics are different from letters; so one may have agnosia for figures. In fact, loss of the ability to calculate is found after lesions in various areas. Semantic aphasia should be mentioned because it is the commonest of all aphasias and is not localizable. It consists

of a quantitative reduction in the capacity for and comprehension of speech. The victim has a litle of all language functions left but cannot put sentences together or express any complex idea. The phenomenon is present in persons with diffuse cerebral lesions, commonly senile, in toxic patients and in normal but excessively fatigued persons. In fact, almost all patients with aphasia have an element of the semantic form, and careful examination will usually show some mental loss. Semantic aphasia is a form of dementia.

The lesions causing dysphasia and dyspraxia are varied, the commonest being trauma, tumor and softening. Treatment is often not pushed as much as it ought to be. When the first shock of the lesion or operation is over, and the patient is comfortable, re-education should be started. First comes accurate diagnosis,* because the physician must first find out what parts of the language mechanism remain intact in order that he may work on and through these normal or less injured parts. Of course it is equally important to learn how much language the patient had before his cerebral lesion. Was he a laborer with a vocabulary of only a couple of thousand words in one language? Was he a waiter with glib use of five languages, or perhaps a college professor with many thousands of words in two or three languages? The diagnosis and prognosis differ in each case.

Having discovered what sort of a person one has to deal with and what is left of the cerebral speech mechanism, one can outline treatment. If the aphasia is complete there is litle to do but to stimulate the patient to more activity and more contact with environment by moving about and occupational therapy. As speech begins to return a place may be found for the entering wedge of treatment. If the case is one of dysphasia ingenuity must be used to make up exercises which will be understood and will re-educate injured cerebral areas or educate the unused area in the minor hemisphere. The evidence is fairly good that the latter is what probably takes place.

* The best short method is that of Cheser, E. C., *Bull. Neurol. Inst. New York,* 1937, 6:134.

For example a patient with visual agnosia cannot recognize objects by sight; he must be shown objects and then be given the cue as to what they are by touch and sound. He looks at the object, feels it and hears the name all at once, and repeatedly. If he has a motor dysphasia with agraphia he is taught to write with his left hand from copy and from dictation. Also he practices speaking words by naming objects while writing the name. The training work is best done by non-medical teachers who have learned the methods in general and who have had from the neurologist special instruction for each case. Goldstein[5] in his recent book shows how varied are the problems and how ingenious the physician must be in planning the therapeutic attack. It is certain, however, that much can be done, especially in young and middle aged people. The teacher must be patient, go slowly and not work long at any one session. A few minutes often tires the patient.

There will be many cases of dysphasia among the many soldiers with head wounds. The specialists in this line of treatment are few and they should begin now to train assistants and teachers to carry out the re-educational procedures. Moreover, many old people with vascular lesions of the brain would be benefited by these methods of treatment, yet most of them are looked upon as hopeless.

Level IVb is actually the same level of structure and integration as IVa, but it deals not only with the function of the dominant hemisphere, but with the relative dominance of the two. Which is dominant and to what extent? In other words there is no 100 per cent use of one and of the other; most persons are very largely right-or left-handed, but 10 or 15 per cent of the population are ambidextrous, have no clear dominance and thus have a lack of leadership in the initiation of speech, writing and reading. There is a mixed lead. One result may be hesitant speech and stuttering; another may be reversed symbols and "strephosymbolia" as described by Orton[6] where letter symbols are confused when similarly formed but differently oriented, as "d" and "b," or words such as "was" and "saw." The left-handed child would like to read from right to left but unfortunately in a right-handed world the books are not

printed that way. Uncertainty of dominance is much more common in infants than later in life when habit has settled the question. In other words a *tendency* to right or left handedness is inherited and is only consolidated by habitual use of one side as a leader. In spite of the fact that handedness is inherited, and therefore dependent upon the structure of the genes, no difference can be seen grossly or microscopically between the right and left hemispheres of the brain.

Physiologically it is obvious that one hemisphere leads in normal persons, but lack of clear dominance occurs often. Clinical evidence is impressive that this mechanism of "mixed leads" causes speech and reading defects. Final proof seems to have come from the laboratory, where Lindsley[7] made electroencephalograms of normal people and stammerers during speech. In normals the alpha rhythm of the brain waves was usually synchronous and smooth. In the stammerers the waves in the tracings from the two hemispheres were frequently out of phase and often obliterated, especially when blocking in speech was observed clinically.

Orton's method of training,[6] aimed at making the patient fix his lead in a chosen hemisphere, is an advance in therapy. One must not, however, think that every ambidextrous child will have difficulty in symbolization; perhaps 10 per cent of the population is somewhat ambidextrous and only about one per cent have difficulty. It is probable that ordinary childhood development takes care of most of the cases; habit and use cure the defect; the child "outgrows" his slight disorder. In the cases where the trouble becomes worse and lasts into adolescence and adult life, to become a real disability, one must look for additional causal factors (see level V).

From the standpoint of treatment, it would seem wise to let a left-handed child work out his own salvation. Do not force him to be right-handed in any way; the world will do that gradually because it is a right-handed world the child is born into. The ambidextrous child needs more care; probably he will choose his lead at an early age and follow it, but if reading or speech difficulty develops, he will need visual, auditory and proprioceptive training

along Orton's lines to make one hemisphere (preferably the left) clearly dominant. The great desideratum is to accomplish the training with as little emotional stress as possible. Let it be simple and matter of fact. Rather than make it seem too important to the child, give it up, keep the home placid, and wait till the child wants help.

At level V is the highest cerebral complexity of integration. Here associations are somehow stored and conditioned, so that they are individual, depend on past experience and when summed up constitute personality. The areas involved are shown in Fig. 5. These are the obverse of Fig. 4, which maps out all the specialized areas. What is left over is shaded in Fig. 5, and represents what one

FIG. 5

LEVEL V—SOCIAL, PERSONAL, EMOTIONAL

Common Lesions: None, or Hereditary

Clinical Results: Stammering, Stuttering, Anxiety, Psychoneurosis

Treatment: Ease Tension, Get Relaxation, Restore Confidence — suggestion, group work, accomplishment; Psychiatric talks, Psychoanalysis, Social Service

supposes, on fairly good evidence, to be the association areas, practically blank in infancy and loaded with personal experience in adulthood. These are the parts of the brain that permit the effect of one person upon another to register and effect character. This associative mechanism allows socialization to take place.[2] When the environment is difficult it is this level of cerebral function that is first affected.

When put under unusual emotional stress, almost anyone stam-

mers. Stammerers are people who habitually hesitate and stick in their speech under stress, but who can talk or read with little hesitation when alone and relaxed. The trouble does not seem to be with the organs of speech, they function well enough when the patient is alone; the essential trouble seems to be in the patient's social relations. He is "shy," cannot "put it over," is afraid to meet people, has varied anxieties and especially has become fearful that he will stammer if called on to speak. Certain sounds are especially difficult, but these vary from month to month and year to year, so it is probable that fear of a certain letter is the cause of the sticking, rather than the sound-formation itself. Any spring board to start the speech and keep it going, like talking in unison or singing, will get rid of the stammer. Putting the patient on the spot by asking him a direct specific question will bring out the blocking in the speech.

For all these reasons stammering is thought to be a psychoneurosis and there is no doubt of the importance of neurosis as one of the causative agents. Everybody probably has stammered at times. It is the child who connects a *fear* that he will stick next time he tries to speak, who perpetuates the stammering into an anxiety state that may last for years. More complicated neurotic mechanisms are usually behind the fear about speech; the child is neurotically anxious and uses speech as the symptom rather than vomiting, bed-wetting, food fussiness or one of the many other possible neurotic expressions.

Experience in treating stammerers has shown that working on the neurosis and paying no attention to the speech will sometimes cure the stammering. Certainly the results of this procedure are better than giving lessons in elocution, breathing, etc. (which almost always make the patient worse) and better than the trick training methods of some of the stammering schools. The tricks of speech learned often help at first because they are taught with much positive suggestion and confidence is gained by the patient.

Probably the best methods are those that combine psychotherapy, socialization and speech exercise. Blanton[8] has written a good book

on this subject. Successful schools that do this well are run by Dr. Green in New York and Mr. Martin at Bristol, R. I. The patients must learn to relax, to speak without spasm, to literally "take it easy." Nothing helps this more than good suggestions, properly and repeatedly employed, and success. The success is the most important thing, it allays fear and builds confidence. Speaking in unison, singing, helping each other, all help the patient to extrovert himself and shed his anxiety.

Sometimes one line of treatment alone will effect a cure. Jacobson[9] in Chicago has had success with relaxation exercises alone. A few instances are known where psychoanalysis worked. Hypnosis has cured a few. But these phenomena must be looked at as examples of taking a few straws from the camel's back. If one wants to be sure to help, it is far better to use several methods of attack at the same time — directed against the *fear,* the *spasm,* and the social withdrawal. Inheritance is an important causal factor but nothing can be done about it. For the patient it is best forgotten; for the therapist, it should be constantly kept mind. Most stammerers probably inherit an inferior speech apparatus (often linked with a left-handed or ambidextrous tendency). This may be harmless unless the social situation and the patient's interpersonal relations precipitate anxiety and fix it into psychoneurosis. The neurosis takes hold of the least resistant system and causes symptoms. The etiology is multiple, and treatment must be varied to match it. The inheritance of a week speech mechanism is no obligation to stammer. Emphasis in treatment should be put on amelioration not cure, for few are ever entirely relieved of symptoms.

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REHABILITATION AFTER INJURIES TO THE CENTRAL NERVOUS SYSTEM

*A Discussion**

PROFESSOR GEOFFREY JEFFERSON: In peace-time most doctors were fully aware that a problem existed in the after-care of those who had suffered a head injury. It was a problem that interested not only the neurological fraternity who saw only a fraction of the cases that existed in the country as a whole, for it was not then, nor is it now, a matter in which any single type of specialist is concerned. The general practitioner is deeply interested, or at least heavily involved, and has a vital part to play. If we disagree sometimes with what he teaches his patients we have ourselves to blame for our teaching to him and, more generally, for our acquiescence with a state of affairs that has vaguely troubled our consciences without our becoming sufficiently aroused to excite concerted action. In civil hospital practice there have been great difficulties (and I fear that they will for some time continue) in pursuing a more rational policy, the chief being the lack of control over the conduct and welfare of his patient once he leaves hospital. One chief difficulty has been the deficiency in bed accommodation in first-class hospitals in which the patient might have been kept until his first stage of convalescence was completed. This has led to the patient rehabilitating himself as best he could under his doctor's supervision. And in an industrial population, which has formed the major part of my own material, this has proved to be a slow process, how slow the following figures testify. I looked up a consecutive series of 50 head injuries seen in private practice during the last two years to find out how soon these cases had been referred for specialist advice for the first time: The average time was six months

* Before the Section of Neurology of the Royal Society of Medicine. December 18, 1941. President: George Riddoch, M.D.

(from three weeks to two years). Many were not seen until seven, eight or nine months or more after injury. By that time a neurosis had become firmly established in a number of the cases, and few were within measurable distance of returning to their work, although most were free from organic nervous defects. The worst offenders are the Insurance Companies, who allow the cases to drag on inconclusively for long periods, before asking advice from a neurological specialist. It is rarely that a case is settled in the High Court or Assize Courts in less than a year.

As to the validity of all headache after a head injury there are many honest doubters (and be it admitted, we have doubts ourselves). We are learning steadily about the mechanism of headache and are abandoning some time-honoured creeds, notably the relationships between pressure and headache as against local distortions of dural septa and traction on, or pulsation of, vessels. We do not yet know with certainty how to apply this knowledge to those with head injuries, except that we have comparative knowledge that pain that continues with unwavering intensity for months on end rarely has an organic cause. But we appear to be at length on the right lines. Attractive as the "unresolved contusion" of Trotter was, it seems unlikely to survive critical scrutiny either as an entity in itself or, it follows, as a cause of persistent pain. I must avoid speaking too much about the well-known post-contusional syndrome, and we must beware, also, of the danger of coming to regard all who have had a head injury as neurotics, though it would not be far wrong to regard all of them, as I believe that we do, as potential neurotics. Too rigid a belief in such a generalization would place the post-traumatic invalids under the shadow of suspicion and medico-legal abuse from which Trotter did so much to rescue them.

What plan can we evolve to rationalize the treatment of these cases, what can we do to improve the lot of those with head injuries? Anything that we, as a profession, do must have as its first aim the benefit of the patient. I do not think that we need have any qualms of conscience on that point. Rehabilitation serves the patient

primarily; it protects the social fabric indirectly. I mean that we are not sacrificing him to the needs of the State, and my experience of our own people is that they are resisting sacrifices at any such altar. Gross abuses have occurred in the past, but they have been wholly in the patients' favour; they are likely to occur again if we find ourselves unable to agree upon a plan and to act accordingly. There is first, the treatment of the patient himself; second, the bringing in of the general practitioner and regimental or unit officers; thirdly, the re-education of the general public which makes up the patient's family, his friends, his employers, his lawyers, and his judges.

Rehabilitation of the Patient: After Head Injury — Rehabilitation may be defined as: "The planned attempt under skilled direction by the use of all available measures to restore or improve the health, usefulness and happiness of those who have suffered an injury, or are recovering from a disease. Its further object is to return them to the service of the community in the shortest time." Although it is a new word, rehabilitation is an old purpose. All medical treatment has basically no other aim. In the early stages of hospital treatment the ministrations and supervision of the physician and surgeon, with their staffs, is to the forefront. It was well recognized in peace-time practice that the discharge of the patient did not denote the end of treatment and by the use of convalescent homes, out-patient follow-ups, and especially by the co-operation of lady almoners, a basis for subsequent supervision was present. It was, however, most used for the purpose of scientific follow-up, much less with the object of placing the patient back in work, and so was imperfect. It would be untrue to say that rehabilitation in the sense in which the term is now used would start only at the point where ordinary in-patient treatment ends, for it should have begun before. But it begins especially at the convalescent stage if we speak of measures which our hospital system has, except in special instances, hitherto lacked. And, what is more, it is carried on until the patient returns to work. It is a continuum closely interwoven throughout with the general medical care of the

patient. It is a work in which all can help, and does not fall within the ambit of any one man or of any one specialty. It is planned so as to give the patient a sense of his own importance as an integral part of the social structure, to give him not only physical but mental employment day by day, and throughout the day to ensure a sense of accomplishment, of achievement. It gives him the opportunity to discover that he is, however much he is damaged, an individual with powers that he can still usefully employ. It affords him the chance of discovering that his wage-earning capacity is not lost and it should allow him to turn to other trades or means of livelihood more fitted to his powers, if that be necessary. Rehabilitation has hitherto been applied only sporadically and there are great inequalities. Indeed, as a national and planned effort rehabilitation cannot as yet be said to exist and the present fluid state of the hospital system makes it a favourable time for an experimental beginning on a reasonably wide scale. These measures should be regarded as an essential part of treatment and should be commenced, in a graded way, *as soon as the patient's condition allows.* Thus, occupation in bed and in the ward is as important as occupation elsewhere for the ambulant patient. In this way the boredom, laziness and loss of adaptability, so often acquired during a prolonged stay in hospital, will be prevented. From the first the patient must be made to realize that he is an active collaborator in his own treatment and that he must accept some responsibility in his progress towards a successful result. At this point it would be as well to emphasize the need for discipline in the E.M.S. Hospitals which varies not only from one centre to another, but from ward to ward in the same place. Complaints about indiscipline reflect on the hospital as a whole.

We do not advocate the imposition of dictatorial rule, believing that co-operation of the patient can be achieved by explanation and reasoning and that habits of tidiness and punctuality can be inculcated without hardship and by example. This is an essential principle in treatment and applies to the relationship between doctor

and patient in all hospitals, whether E.M.S. or not. The methods to be employed in such treatment should include:

(1) Diversional and also constructive occupations of sufficient variety and varying degrees of difficulty for those still confined to bed, as well as for those who are ambulant.
(2) Hospital maintenance work in the ward and outside.
(3) Physiotherapy, remedial exercises, massage, physical training.
(4) Intellectual and recreational pursuits.

Stages in Rehabilitation

Rehabilitation may be divided up into stages corresponding with the progress of the patient from his original admission to hospital, through to his discharge and back to his home and employment.

Stage I

This covers the period during which the patient is in hospital—confined to bed or ambulant and is undergoing the early treatment appropriate to the local repair of his injury. Both Service and civilian casualties are included in this period under the agreement by which the E.M.S. cares for the injured, whatever their employment. In this stage the actual time at which the patient's interest is specifically aroused cannot be laid down definitely, because it will vary with the severity of the injury, the speed of recovery, the patient's age and intelligence, and the degree in which mental alertness and ability to co-operate have been depressed by the injury. But it should be laid down that rehabilitation in a diversional form should be instituted early whilst the patient is confined to bed. It will take the form of: Reading or being read to; jig-saw, cross-word, and other puzzles; drawing or colouring; needlework, string net and basket making; sewing, knitting, rug-making.

Speech Therapy —...The retraining of speech by a Speech Therapist will be required in most cases of dysphasia. This treatment should be started when convalescence is well established, about the third or fourth week. For ambulant patients and those in wheelchairs rehabilitation will be continued by book-binding; string and basket work; leather and metal work; simple carpentry, &c. Enter-

tainments by concerts and films and, for the walking cases dancing is already available in some Brain Injury Centres. Patients after head injuries are often disturbed by noise and especially by general conversation. They may become distressed in a room where a gramophone is playing and other people are talking or playing games. A silence room of fair size and attractiveness should be set aside for them.

One of the most important services which rehabilitation will perform is that by instituting occupation to a time-table, the patient's day, or a considerable part of it, is dedicated to some pursuit. Clearly all such arrangements must be suited to the clinical state of the individual and the time-table will be most applicable to those advancing well in their convalescence. No doctrinaire rigidity is intended in any of the suggestions here advanced, which are to be applied with insight and judgment and modified from day to day, as needs be.

The scheme of rehabilitation above outlined refers to the patient with an uncomplicated head injury. If serious injuries exist elsewhere they might predominate and necessitate such modification of the plan as common sense dictates.

PHYSIOTHERAPY will be required (it has of course already been provided in all the Brain Injury Centres). Physiotherapy should not dominate the general rehabilitation scheme which is a co-operative affair in which all branches play a helpful part. Undue emphasis has come to be laid on physiotherapy (massage, medical electricity in its various forms, and remedial gymnastics) because it has been the only kind of treatment commonly provided hitherto. Our hospitals, whilst well equipped for these treatments have lacked any organization for other convalescent pursuits, especially those that retrained the mind and took account of the personality and idiosyncrasies of the patients. It is our belief that of the two kinds of treatment, mental occupation and encouragement to do things, to make things, to use the whole body, is much the more important. Physiotherapy occupies a very small part of the patient's day and, except for remedial exercises, does not demand his co-

operation. He is free for the rest of the day to follow the path of least resistance so that he tends to become the passive recipient of occasional treatment, dependent on others to get him well. However skilful physiotherapy may be, and it is commonly technically very skilful, many patients (not surprisingly) make slow progress.

The patient convalescent from head injuries is something very different. He should be urged to use his mind and to take an active part in his treatment, which will, without his interested co-operation, surely fail. With the other types of occupation included in rehabilitation there are things which excite interest over many hours of the day. In several, e.g. where things are made with the hands, the important stimuli of competition and mimicry come into play, whilst in his constructive attempts he makes those very movements of his own with which physiotherapy teaches him for such short times and at intervals.

That the benefit of physiotherapy is often chiefly psychological cannot be denied, but this very fact calls for its intelligent use and the avoidance of misuse. During that stage of rehabilitation which coincides with the earliest stages of recovery, massage and encouragement to move paretic limbs will be the chief function of physiotherapy. Electrical methods are not advisable in the upper neuron lesions which form practically the whole of the material—the only exceptions will be the occasional facial nerve injuries and injuries to a limb or to peripheral nerves.

Stage I will last for about six weeks. This time might have to be extended in patients with chronic infections, cerebral fungus and the like, and those needing extended speech retraining. Modern surgical methods, and especially the new antiseptics give us grounds for the belief that long residence in hospital for purely surgical reasons connected with the wound will be uncommon.

The Place of Psychology in Rehabilitation — A bold statement on this question is necessary, and my belief is this that the proper use of the psychologist is that he should give reports on cases of head injury in much the same way that reports are given by other specialists, such as the radiologist and pathologist.

Whilst it is often instructive to know the intelligence quotient of a patient, it is more important for our purpose to assess his character, his emotional qualities, his recognition of values, his reactions to problems, his aims in life.

In the more serious injuries, where some degree of traumatic dementia has occurred, the psychiatrist's experience will fortify us in estimating the degree of mental damage.

Stage II

After some six weeks have elapsed since the injury we should be in a position to gauge the prospects of a case. Judged by experience from neuro-surgical operations, where variable degrees of considered and carefully inflicted damage is done to the brain, we know that in some six to eight weeks the effects of the operation have passed away. Reflections of this kind are important. Who can doubt that the two to three week period of invalidism that follows a section of the trigeminal root for neuralgia, or the slightly longer period after an operation for a pituitary adenoma, would be enormously extended in time were it the result of accident. Most scars are healed in two months, and after that period has elapsed the pain of a fractured skull (and I believe that most clinicians underrate bone pain) should have faded away.

Once symptoms have abated, the second stage or period of hardening commences. It seems desirable that military cases should be taken over by the respective Services for this purpose, since this gives an opportunity for canalization towards the specific goal of their line of work, whichever it may be. I shall leave discussion of the management of Service cases to the proper authorities. I will, however, outline the types of activity which are useful once the patient is fully ambulant and relatively free from complaints.

It is at this point, when daily medical and surgical supervision is no longer needed, that we advise separation of the military or Service casualties from the civilian, and it is here that the chief reconstruction and replanning between the E.M.S. and the Services will be advisable. Service patients recoverable for Service purposes

ought to be rehabilitated in Service Deposit under discipline and in Service pursuits.

Invalided Service and Civilian Patients — The methods of treatment to be employed will be, in the main, the same as in Stage I, but with additions such as: (1) Gymnastics and physical training. (2) Continuation of physiotherapy when necessary. (3) Basket making, leather and metal work, the patient being allowed to keep the finished article on paying the cost of materials. (4) Speech-training for those with dysphasias. (5) Work in the garden. (6) Work in the carpenter's and engineer's shops. (7) Organized games—cricket, football, netball, baseball, rounders, and open-air games. (8) Walks outside the hospital grounds. (9) Visits to the town, shops and cinema, but usually with the purpose of finding out how the patient reacts to the jostle of people and the noise of traffic, to navigating himself as an entity amongst his fellow men. The same of visits to the cinema—how well does he sustain visual and auditory attention over a period of two hours or so and is he upset by the incidental noise? No patient with a head injury should go on a bus or train journey until he has proved his ability to look after himself in this way.

It is not intended that these visits should be purely educational or therapeutic, but it is important that the doctors, in whose charge the patients are, should realize the lessons to be learned from these extramural activities. The patients must therefore be questioned about their reactions to these excursions, and progress notes made.

Physiotherapy will be applied where it is needed. The recreational side, such as attendance at dances, will be more in evidence.

An essential of rehabilitation is that it should be planned to a time-table each day. Patients should continue with a pastime or constructive work only for definite periods; he should be stopped whilst he still wishes to go on. In that way interest is maintained. Hence application at any one thing should be relatively short, especially in the earlier days of convalescence. The best plan will be to arrange 6 sessions for each patient in the day of from forty-five to sixty minutes each, say from 9 to 12 and from 1.30 to 4.30.

Everyone should be told his duties for the week with, say, Wednesday and Saturday afternoons free.

After six weeks or so in hospital with plenty of interest during Stage I he might feel himself quite well enough to return to home and to work without further preparation. It may be objected that patients will be reluctant to continue with further treatment, preferring to go home. The confidence of the patient in his treatment and the enthusiasm with which his doctors are able to advocate a continuation will determine his willingness.

The most important stage of rehabilitation is the first. The patient should be frankly told what sort of an injury he has had and what we expect the course of it will be. A great deal of our difficulties in the past have arisen because we have not been able to retain our head injury cases for long enough. Much can be done by giving the patient's doctor not only the history of the case, but also warning him against the possibility of the patient becoming a passive resister to cure. The mental resources of many of the industrial population are so few that the wonder is how they fill in the weeks and months and sometimes years that they spend in recovering. We can do much by establishing contact with the general practitioner and his counterpart in the Army, the Regimental Medical Officer. Further, by speech with the wife or relatives of the patient we can make them aware of the most important facts about head injuries and their course and can divert them from a degree of over-solicitude.

Professor Hugh Cairns: In any discussion on rehabilitation of head injury patients it is important to consider the main factors which influence the patients' disability.

(1) *The time factor.*—The time factor varies greatly from case to case. After a head injury the patient goes through a cycle, beginning with unconsciousness, thence through a stage of confusion and a period in which he is liable to headaches, to a final stage in which he is restored to normal or near-normal. This is a spontaneous process. The time taken for its completion may be in one case only a few weeks, in another as long as eighteen months, de-

pending to a large extent upon the severity of the initial injury.

This time factor must always be taken into account in planning the rehabilitation of head injury patients, the more so because we do not yet possess adequate tests by which to measure the recovery of the higher levels of intellectual function. A man may appear on testing to have recovered his faculties completely, and yet he will fail on the intellectual level when he returns to his work. In deciding when a patient should be fit to return to work it is therefore necessary to bear in mind the severity of his injury, and the best yardstick at present available is the duration of the post-traumatic amnesia (P.T.A.). As a working rule I would suggest that the shortest time in which ability to carry out full work may be expected to return is as follows:

P.T.A. 5 minutes—1 hour	4—6 weeks
P.T.A. 1—24 hours	6—8 weeks
P.T.A. 1—7 days	2—4 months
P.T.A. over 7 days	4—8 months

I put this forward tentatively as a rough measure to be used in planning rehabilitation. It can be no more than a rough working guide because the duration of post-traumatic amnesia is influenced by other events besides the severity of the brain injury, e.g. the amount of bodily fatigue present at the time of injury, large doses of morphia or a general anæsthetic shortly after the injury, epileptic seizures in the first days after injury, and various psychoneurotic factors. Furthermore, we know that in certain cases where there is a fracture of the base of the skull and the amnesia is shortlived, damage to the cranial nerves may interfere with return to work long after the higher cerebral functions have recovered. The type of work must also be taken into account; a simple task may be resumed earlier than one which involves the higher levels of intellectual function.

(2) *Disturbance of mental capacity.*—The central disturbance, the main organic cause of disability after head injury, is disturbance of mental capacity. It may occur at various levels of mental activity. At the lower levels there may be disturbance of speech, reading,

calculating, or orientation. Initiative, memory and concentration may be affected. At higher levels there may be impairment of judgment, or of the capacity for abstract reasoning. The patient cannot be satisfactorily guided through the stages of rehabilitation without an attempt on the part of the doctor—however halting it may still be—to assess his mind in terms of these functions. After severe head injury the question will arise whether the patient is likely to be fit for his previous work, and this will often largely depend upon his retention of the capacity to learn. While the patient continues to show improvement an adverse decision should usually be withheld.

(3) *Emotional disturbance.*—Emotional factors are inextricably bound up with the process of recovery. The unstable type of man will have additional difficulties in adjusting himself to the task of returning to work, and it is therefore incumbent on those responsible for rehabilitation to assess the man as well as the severity of his injury. This is best done not only by observing the patient's behaviour while under observation, but also by a systematic inquiry into his family history, and into his earlier life and illnesses. The doctor may learn, especially in the cases of soldiers in war time, that before his accident the man was not employed, or felt that he was not employed in the type of work for which he was best fitted.

Emotional disturbance may interfere with all aspects of intellectual activity and may be itself precipitated by these defects. The patient who becomes confused at a task tends to have a feeling of inadequacy which may lead not only to headache and outbursts of irritability but also to complete suppression for the time being of his powers of thinking: the phenomenon described by Goldstein as the catastrophic reaction.

(4) *Post-traumatic headaches.*—Anyone who is responsible for the rehabilitation of patients with head injury must formulate his ideas about the post-traumatic syndrome—the attacks of headache, dizziness, irritability and confusion which occur so commonly *after* the initial recovery from head injury. There are large gaps in our knowledge of this syndrome, and no little disagreement as to its

nature. It is necessary, nevertheless, to have some working hypothesis, otherwise what shall one say to the man who complains of headaches during convalescence? I believe that almost every patient who makes a full recovery from concussion suffers at a certain stage of his recovery from headaches. In the mild head injuries the headaches may occur sporadically for some weeks and then disappear. In the severe cases the headaches may not come on until long after the patient has left hospital, and may not come on at all if there is any serious degree of residual organic defect. The patient must have recovered a certain amount of mental clarity before he appreciates headaches.

Now it is one thing to have a headache; it is another thing to complain about it. Although attacks of headache occur fairly constantly the reaction of the patient to them varies considerably, depending on a variety of factors, such as the emotional make-up of the patient, his anxieties and fears, his ability and desire to cope with his work once more. Emotionally stable, well-adjusted, and reliable witnesses—for example, most doctors—will describe their difficulties in concentrating when first they return to work; they will ascribe their headaches to attempts to concentrate, their headaches or dizziness to exertion or change of posture. Identical symptoms are complained of by other patients who are unstable and badly-adjusted, but nevertheless reliable witnesses. The difference is that the first type will manage to carry on with their rehabilitation with the minimum of interruption, while the second type are likely to break down on return to work unless they are given special treatment, treatment that inevitably comes within the purview of rehabilitation.

If this view as to the incidence of post-traumatic symptoms is correct then we must regard the syndrome as organic, just as syncope is; but, like syncope, it is influenced by emotional and psychoneurotic factors.

The Early Stages of Recovery — Rehabilitation begins when the patient begins to talk and respond properly. How does he discover that he has had a head injury? As his confusion clears he

slowly puzzles it out for himself, with the aid of explanations which come better from the doctor, with reassurance, than from the relations. The explanations and reassurance may need to be repeated more than once, for although the patient may be able to conduct a conversation in a manner that gives a superficial appearance of normality, yet he is at this stage confused, disorientated, and forgetful, for a period varying between minutes and weeks, according as the brain injury is mild or severe.

This is the stage at which assessment of the brain damage and of the type of the patient can first be undertaken. Without such investigations the rehabilitation cannot be adequately planned.

Getting Up — Notwithstanding the recommendations of Symonds these patients are often kept in bed too long, on the assumption that the liability to post-traumatic headaches is thus diminished. There is no evidence in favour of this view, and the practice becomes a bad one when, as so often happens, the next stage of rehabilitation is hurried.

There is rarely reason why the patient should not be allowed to get up a few days after he has recovered consciousness. Thus, a man whose total amnesia is six hours or less can be got up gradually towards the end of a week. If he gets a headache, he can be put to bed with some aspirin, and can get up again next day. Recourse to bed is, however, rarely necessary, for headache is not a conspicuous feature of this stage of recovery. The fact that the patient is got up early does not mean that he is to go back to work early. In cases of prolonged confusion and irritability, after unconsciousness of a week or more, the effect of sitting the patient out of bed and of giving him baths is often most soothing.

Graduated Physical Activities — From the stage of getting up graduated physical (and mental) exercise may begin. It is necessary to grade the exercises, and the speed with which the patient passes from one stage to the next depends, not only on his progress with the exercises, but also on the estimated severity of his injury. For the mildly concussed the physical exercise can take first the form of walking and light physical training, thence by

stages to more strenuous physical training, games, and heavy physical work. For the severely injured who, when they first get up, are still confused and even disorientated, light exercises to music, gentle indoor ball games, and deep breathing exercises are useful. These patients need much individual attention, and plenty of rest between exercises. Patience is necessary, also, for they often forget a game and need to have it explained to them all over again. No exercise should be pushed to the point of provoking a catastrophic reaction.

What is the value of physical exercise? It hardens the patient physically, thus preparing him to adjust himself the more easily to the physical demands of his normal life. It provides also a sense of achievement which is valuable in a man who is mildly confused and incapable of concentrated mental effort. It helps him to escape boredom. And it is perhaps also beneficial in modifying intracranial pressure.

At what stage should the patient be called upon to do violent physical training, Swedish exercises, and the like? Opinions differ on this question. There are some who would start it within a few weeks of quite severe injuries; others would introduce it more gradually and at a later stage. Before doing severe exercises the patient should, in my opinion, pass successfully through a stage of light competitive games.

Occupational Treatment — While physical re-education is going on handicraft can provide simple tasks within the powers of most patients, tasks which occupy their time at a stage when they are incapable of reading or talking consecutively for any length of time and which give them a sense of achievement: leather-work, basket-work, poker-work, weaving at a hand-loom, and book-binding. Heavier crafts such as carpentry, metalwork, weaving on large looms, and outdoor occupations, such as gardening and house-decorating, come later.

In craft work the teacher must constantly bear in mind that what really matters is not the initial standard of performance, but the degree of improvement shown from day to day. So often the star

pupil of the class proves to be a psychoneurotic with headache after a trivial head injury.

MENTAL EXERCISE — The simplest mental exercises are those connected with movement, where the alternations of movement require concentration. For the confused patient simple games of a childish kind without competition are useful, for example, sorting cards according to colours, shapes, or what is written on them. It is an index of their degree of confusion that grown men will play these games with considerable pleasure.

In the later stages mental exercises should be directed towards the specific defect. Testing of the mental processes comes first and is in itself treatment. Special exercises can be introduced for lower level defects, such as those of reading and calculating. Sometimes it is possible to supplement the damaged functions, as, for example, by encouraging the patient with a defect of reading to trace or copy the words he is trying to read, or by teaching lip-reading to a patient whose difficulty is in understanding the spoken word. The prognosis depends on the residual learning capacity.

It is doubtful whether special, graded mental exercises can seriously compete with the patient's own attempts to re-educate himself, once he has, by testing, been shown the way; but the value of encouragement by means of continued supervision cannot be overestimated.

VISUAL TREATMENT — No patient can relearn intellectual tasks unless his sight is good, and as many of these patients have visual symptoms, diplopia, phorias, or errors of refraction, it is important that ophthalmological treatment should be given whenever necessary.

PSYCHOLOGICAL FACTORS — The importance of psychological factors has already been indicated, and no attempts at rehabilitation are likely to be successful unless the patient's anxieties and fear are assuaged and unless he is helped through the phases of depression and the other disturbances of feeling that so often beset him during recovery from head injury.

THE FINAL TEST — It is very difficult in hospital or convalescent

institution to provide a test of full recovery, and the final test is the patient's return to work. It is the duty of those in charge of rehabilitation to see that the man is adequately supervised during this period, and that any special points concerning graduation of his work in the initial stages should be made known to his family doctor, his works doctor, or his Unit medical officer.

Dr. W. Russell Brain: For a long time it has seemed to me that the high incidence of neurosis after injury, particularly after industrial injuries, and our continued neglect to deal with it as a substantial medical and social problem is a considerable reproach to us as doctors. The first step must necessarily be an attempt to ascertain why traumatic neurosis occurs. The question can be approached in two ways, either by a psychological investigation of patients suffering from neurosis after injury, or by a statistical inquiry into the characteristics shown by a group of such patients. The two methods are supplementary. Psychological investigation of injured individuals is difficult for many reasons. My method is the second one and I shall concern myself only with such psychological facts as seem to emerge from a study of the group as a whole.

I have long had an impression that traumatic neurosis occurs much more frequently in patients suffering from the effects of industrial injuries than in those injured in road accidents, and this supposed difference suggested itself as a promising basis for an inquiry. I have therefore taken as my material 100 consecutive cases of male patients suffering from the effects of a head injury acquired in a road accident, and 100 consecutive cases of male patients suffering from the effects of an industrial head injury. All patients were seen some time after their injury, the average interval before they came under observation being ten months. I have divided the patients in each group into three sub-groups according to whether their head injuries were mild, moderate or severe. I have called mild those injuries in which either consciousness was not lost or the patient was merely dazed for a short time. I have called moderate those injuries in which consciousness was lost, but the patient had re-

covered normal mentality in twenty-four hours and I have classified as severe all cases in which loss of consciousness or mental confusion lasted for more than twenty-four hours. The state of consciousness, however, though important, is not the sole criterion of the severity of a head injury and I have taken into account severe focal cerebral contusion when this occurred with only brief loss of consciousness. I have also divided each group into three sub-groups according to whether I consider the patient's symptoms to be purely organic, purely neurotic or mixed. It is clear that this classification depends to a considerable extent upon personal judgment. There is no difficulty in deciding about most hysterical symptoms. In assessing the nature of other symptoms I have depended upon such criteria as the characteristics of the headache, especially its constancy or otherwise and its relationship to precipitating factors, the effect of the passage of time upon symptoms and the attitude of the patient to them. No doubt others would have classified individual cases differently, but perhaps this is not of great importance since the same methods have been applied to all the cases by the same observer.

Incidence of Neurosis After Road Accidents and Industrial Injuries

Table I shows the frequency with which neurosis follows head injuries (1) after road accidents and (2) after industrial accidents.

TABLE I.

	Neurotic	Mixed	Organic
Road accidents—100 cases	8	15	
	23		77
Industrial accidents—100 cases	23	32	
	55		45

The next step is to inquire whether there is any correlation between the incidence of neurosis and the severity of the injury. This is shown in Table II.

TABLE II.

	Neurotic	Mixed	Organic	Total
Road accidents—Severe	1	11	48	60
Moderate	3	2	18	23
Slight	4	2	11	17
Total	8	15		
	23		77	100
Industrial accidents—Severe	4	8	22	34
Moderate	8	12	10	30
Slight	11	12	13	36
Total	23	32		
	55		45	100

Table II shows, first, that the injury is severe in a much higher proportion of patients who have had road accidents 60% compared with 34% of those who have had industrial accidents; and secondly that the industrial group shows a high incidence of neurosis associated with the less severe injuries, which is not present in the road accident group. This is better shown in Table III.

TABLE III.

	Neurotic and Mixed	Total	Percentage
Road accidents—Severe	12	60	20
Moderate and slight	11	40	27
Industrial accidents—Severe	12	34	35
Moderate and slight	43	66	65

It is quite clear that a severe head injury as such is not an important cause of traumatic neurosis, but we have still to explain the apparently paradoxical correlation between neurosis and the slighter injuries.

It must be remembered that we are here dealing not with totals of injured persons, but with persons selected from the total number injured because the severity of their symptoms (1) in the road accident group calls for compensation (2) in the industrial accident group incapacitates them for work. It will generally be agreed that the incidence of severe head injuries is much higher in those

who have been involved in road accidents than in a group exposed to the varied hazards of a large number of industries. Allowing for the fact that in some industries the risk of head injuries is much greater than in others it is still true that a mixed group of industrial workers is exposed to somewhat rare severe injuries, and fairly frequent moderate or slight injuries. If now the incidence of neurosis is independent of the severity of the injury, if, in other words, there exists in the exposed community a proportion of individuals who react to even a slight injury by developing a neurosis, the high proportion of less severe injuries will lead to a selection of these susceptible persons, since those with slight organic symptoms will soon return to work and therefore will never reach the neurologist. Hence there will be an apparently high incidence of neurosis complicating the slighter injuries, in the industrial group.

But in the industrial group the 35% incidence of neurosis complicating severe injuries is significantly higher than the 20% in the road accident group which may perhaps be regarded as a sample of the general population at these ages; and the generally raised liability to neurosis in the group calls for explanation.

Age and Occupation

There is no significant difference in the average age of patients in the two groups, nor between the average ages of those with and those without neurosis in either group, so that there is no evidence that age plays any part in the ætiology of traumatic neurosis.

There are significant differences in the incidence of neurosis in different occupations in both groups. This is shown in Table IV.

TABLE IV.

Occupation	Total	Neurotic	Percentage
Road accidents—			
Professional and clerical	38	4	11
Skilled artisans	27	5	19
Light unskilled	14	6	43
Heavy unskilled	19	7	37
Unclassified	2	1	—

Industrial—			
Professional and clerical	2	—	—
Skilled artisans	20	7	35
Slight unskilled	19	10	53
Heavy unskilled	59	38	64

This table shows first that in both groups the incidence of neurosis is highest in the unskilled labourers; in fact out of 23 patients in the industrial group who developed neurosis after slight injuries 17 were heavy unskilled labourers. Secondly, men of any occupation are substantially more likely to develop traumatic neurosis if they are injured in an industrial accident, even though their organic injury is likely to be less severe. I would briefly suggest two reasons why a slighter industrial injury is more likely to produce neurosis than a more severe road accident.

First, an industrial injury is an occupational injury, as a road injury usually is not. It therefore suggests to the workman that his occupation is a dangerous one, and it is likely to cause a sense both of physical danger and of economic insecurity. Second the legal procedure is widely different in the two groups. In a road accident the insurance system is a guarantee of compensation in most cases: in the machinery of the Workmen's Compensation Acts it operates in the opposite sense, since the workman's right to compensation is repeatedly under review and frequently contested. Hence although the workman injured at work receives immediate compensation which his fellow knocked down by a car does not, his economic security is really far more seriously threatened. There are other defects, of a similar kind, in the Workmen's Compensation Acts which contribute to the development of neurosis but which I cannot now discuss.

Suggested Remedies

(1) Rehabilitation in all cases of slight injury begins with the general practitioner or casualty officer who first sees the patient. These front-line workers need to learn the right psychological handling of the injured man; to avoid suggesting serious injury

when none exists and equally "a narrow escape". They should learn also to avoid the hospitalization of really slight cases.

(2) All big centres need units of doctors trained to deal with head injuries, both slight and severe. In this way only is it possible to avoid the ill-effects of scattering these patients in general wards under the care of surgeons who have neither the knowledge nor the interest needful.

(3) Occupational therapy should merge into therapeutic occupation, i.e. organized light work, adjusted to each man's capacity.

(4) The social responsibility for the injured should be more widely recognized and the emphasis changed from compensation to rehabilitation. The need for compensation is to a large extent a measure of the failure of rehabilitation.

(5) The Workmen's Compensation Acts should be revised so that an industrial injury should not immediately involve a potential dispute about the ownership of a sum of money. Medical issues should be decided by medical boards closely linked with rehabilitation units; and an adequate maintenance allowance should be guaranteed to the injured man as long as the medical board regarded him as disabled and as long as he co-operated in his treatment and rehabilitation.

(6) At the same time it is important to avoid an exaggerated paternalism. Here we have to face an aspect of the largely unsolved problem of modern society, how to provide social services without robbing the individual citizen of his sense of responsibility for his own welfare. There would be no traumatic neurosis if all the injured were like an Irish hunting woman who consulted me because after the last of many falls she thought her double vision was worse than it used to be. Such toughness is doubtless partly innate, partly cultural. Society can do a good deal to foster it if it is conscious of the need. As doctors we have the double task of educating both individuals and society.

Dr. Ludwig Guttmann: Rehabilitation after peripheral nerve lesions means restoration of the working capacity of the injured

person. It includes, apart from the actual surgical treatment, all methods which accelerate functional recovery:

(1) Therapeutic arrangements of a more passive or preventive nature, such as precautions for keeping the paralysed limb in the right position with and without splintage and physiotherapy.

(2) All arrangements which accelerate functional recovery with the patient's active co-operation until he is enabled to resume his former occupation, or failing that to do useful alternative work in the same industry. Arrangements of this group are (*a*) remedial exercise; (*b*) occupational therapy; (*c*) some physiotherapy; (*d*) reconditioning.

(3) Vocational training, i.e. training of those crippled by peripheral nerve injuries for special occupations adapted to their permanent disability.

As there are some transitions between the individual groups this distinction may not be considered as absolutely strict. According to this definition it is obvious that rehabilitation after peripheral nerve lesions has to start immediately following injury. Dr. E. A. Nicoll's opinion expressed on this subject in a recent paper on fractures "Rehabilitation starts on the first day of treatment" can be accepted in the full meaning of the words also for peripheral nerve lesions.

General Organization — The installation in this country of several centres for the treatment of peripheral nerve injuries is a great step forward. The congregation of cases in a single department under the same specialized staff, with continuous treatment under the same supervision, is certainly the best guarantee for a systematic study of the whole question, and for better results. The success of a centralized treatment and care of peripheral nerve injuries in other countries was shown by the "Peripheral Nerve Centres" in the U.S.A. during the last war and particularly by Foerster's work in Germany during and after the last war. His material included about 4,000 cases. Although he worked under conditions by no means ideal compared with those of a modern centre in this country, his results were remarkably good and better

than those of many other authors of that time. Foerster has emphasized again and again the secret of his better results. It was only in some respects a specialized surgical technique; the main reason was a better and systematic after-treatment and after-care, in other words, a good understanding of rehabilitation.

The installation of centres for peripheral nerve injuries, however, does not cover the whole problem of organization in the rehabilitation work. In practice it is not possible to bring all cases into these centres, particularly in the early days after injury. Therefore precautions should be taken in all General and Military hospitals, *particularly in Military Base-Hospitals,* that the injured can be seen immediately by a Nerve Specialist versed in the after-treatment of peripheral nerve lesions. Neglect of this vital principle of rehabilitation in the first period, even in the first days after injury, accounts for much of the prolonged disability of the injured person, with all its economic consequences. The importance of this point can hardly be exaggerated. An integral part of the organization of what might be called "Primary rehabilitation service" is a thorough record of all treatment given in the first period after nerve injury. Undoubtedly such a service would greatly facilitate the work of the centres for peripheral nerve injuries and would play a big part in improving the end-results.

Of the same importance as the primary supervision immediately after injury is the late supervision of these cases after their discharge from hospital, from the centres and from the Army. This late supervision also includes the post-war supervision of peripheral nerve injuries. Experiences in all countries after the last war have clearly shown that any successful late supervision of these cases can only be achieved by a loyal co-operation of the medical authorities with the public health services and—as Cairns and Young pointed out (1940)—with the Ministry of Pensions and, last but not least, with the employers. Such an organized co-operation of the various authorities concerned with the rehabilitation work is of particular importance in the reconditioning period of the injured. One of the main tasks of the "after-care service" is (1) to provide

the injured man with light and graduated work in his former occupation until he is fit for heavy work; (2) to supervise this light and graduated work. In my own experience the best results in supervising the injured persons during the reconditioning period were obtained with the help of industrial medical officers and general practitioners. Experiences in all countries have shown that many patients, left alone in the reconditioning period, will never make sufficient effort to reach their full working capacity.

In discussing some methods of particular importance for a speedy and, if possible, complete rehabilitation only a few points can be considered. Cases with peripheral nerve lesions can be grouped into those in which restoration of nerve conduction is possible and those in which there is no chance of nerve regeneration. In regard to treatment, however, this distinction is not an absolutely strict one as similar principles have to be considered in both cases up to a certain point.

Position of Paralysed Limbs

The position of paralysed limbs follows the principle of close approximation of the points of attachment of the paralysed muscles. The principle underlying treatment is to maintain and increase elasticity of the affected muscles. All experts on the subject agree that overstretching of a paralysed muscle even in the very first period after injury means a severe and often irreparable additional damage of the paralysed muscle. In 1916 Sir Robert Jones expressed it very clearly: "The most skilful operation performed on the most suitable case will prove a fiasco unless the affected muscles are continually kept relaxed until recovery takes place." Unfortunately, this well-known and most essential point is in practice not always duly considered and may even be completely neglected. It is for instance amazing how often this principle is neglected in cases of ulnar and median nerve palsy in spite of the fact that special splints have been described for the approximation of the intrinsic muscles of the hand.

In preventing the claw position of the fingers in cases of ulnar

nerve palsy two types of splints are recommended. The one is designed to maintain the proximal phalanges in a position of medium flexion, at the same time preventing flexion of the middle and terminal phalanges. The other, recommended particularly for isolated paralysis of the interossei, maintains the greatest possible extension of the long flexors of the fingers by means of narrow elastic splints which are applied to the dorsal side of the fingers, thus extending all phalanges as far as possible. The advantage of these splints, according to Foerster, lies in the fact that the middle and terminal phalanges remain sufficiently stretched during all the finer activities of the fingers in which small objects are grasped and moved between the tips of thumb and index or middle finger.

In median nerve palsy, in which relaxation of the thenar muscles is so important, splints have also been designed to bring the thumb into a position of abduction and opposition while its terminal phalanx is extended. Among other authors Foerster (1929) has recommended such a splint, which, however, tends to be too inflexible. On the other hand splints, such as recommended by Sumner L. Koch and Michael L. Mason (1939), which are more flexible have the disadvantage that the thumb is held in adduction and in too strong flexion at its metacarpo-phalangeal joint, and they do not give the necessary abduction and opposition of the thumb. The problem of suitable splints for isolated median palsy and also for combined median and ulnar or radial palsies is therefore still unsolved. Whatever splintage may be used it is of vital importance that any direct pressure of the splint on the paralysed muscle must be avoided, and "splint-free" intervals should be given.

Strengthening of Synergists

The taking over of the function of a paralysed muscle by one or several of its normal synergists can be of great practical value in rehabilitation. Besides the well-known compensatory function of the brachioradialis in a biceps palsy and other instances the following example illustrates this principle: In a case of complete paralysis

of the axillary nerve abduction of the arm may be carried out astonishingly well by the supraspinatus muscle. It is possible in such cases to dispense with splints altogether and to restore function and working capacity by strengthening such synergistic muscles.

Electrotherapy

It is one hundred years since John Reid in Edinburgh (1841) first described the beneficial effect of galvanic current on denervated muscles. Since then opinions about the value of electrotherapy in the treatment of peripheral nerve lesions have oscillated a great deal. Experiments on the subject do not allow satisfactory conclusions, and even the great clinical experience of the last war has not settled this problem. Yet experts are agreed that electrotherapy is useful in accelerating rehabilitation after peripheral nerve lesions. My own experience has endorsed the value of electrotherapy carried out by galvanic exercise of the paralysed muscles. If carried out regularly and properly by a reliable person having the necessary knowledge of the anatomy and physiology of movement and under permanent medical supervision it is a valuable auxiliary method in the treatment of atrophy and in maintaining or improving the elasticity of paralysed muscles. This has been proved recently by an experimental study on galvanic treatment of denervated muscles in rabbits carried out in Dr. J. Z. Young's Department of Comparative Anatomy in the University of Oxford by Dr. Ernest Gutmann and myself (1942). Although in these experiments the daily galvanic exercise of the paralysed muscles did not entirely prevent the onset and progress of atrophy immediately after denervation, it had, however, a definite delaying and diminishing effect on the atrophy in later stages. Moreover it accelerated the recovery from atrophy, once the muscles had become reinnervated and recovery of function had commenced. The histological findings in our cases eliminate the suspicion that the greater volume of the treated muscles might be the effect of a hypertrophy of the connective tissue. Exactly the reverse was found, for the treated muscles showed far less fibrosis.

It may be noted that in cases of complete paralysis galvanotherapy is the only method (in contrast to massage) which enables the paralysed muscles to exercise their original function—or to put it in Foerster's own words: "Electrotherapy reminds the paralysed muscle of its normal task." Furthermore electrotherapy is most useful in augmenting active exercise in those cases in which regeneration is taking place but the patient cooperates poorly. On the other hand, it would be overrating the value of the method to imagine that atrophy of muscles can be prevented or considerably diminished in all cases of denervated muscles. In my own cases in which great vascular damage had occurred in addition to the nerve injury or in which the muscles themselves had been very considerably damaged the beneficial effect of galvanic treatment was not so convincing.

Remedial Exercise

Active exercise is of *cardinal* importance in achieving the most complete and quickest rehabilitation. In recovering lesions three different stages require special consideration:

(1) As long as voluntary movements are still weak the exercises should only be directed towards overcoming the inertia of movement, and should not work against gravity. The simplest way to achieve this is by placing the limb in such a position that movements are carried out in the horizontal plane. Exercises in a bath are in some cases helpful.

(2) Having overcome the inertia of the limb without any other help, exercise should be attempted against gravity.

(3) If the muscle is able to move the limb against gravity, graduated weights are added against which the muscle has to work.

The principle of the exercises is to effect quick movements over the widest possible range. This kind of exercise has always to be supervised since the patient when left alone is usually inclined to exhaust himself in multiple partial performances as opposed to a few maximal responses which are of greater benefit. Since many patients never make progress without assistance a *daily* supervision of active exercise by the doctor has undoubtedly the best effect in

obtaining the patient's energetic co-operation and unremitting effort which are so necessary for successful rehabilitation.

Occupational Therapy

Occupational therapy at the centres for peripheral nerve injuries might be a valuable addition to active exercise treatment. In cases where restoration of nerve conduction is possible it will accelerate rehabilitation. In cases of permanent paralysis it will help to develop and to improve subsidiary and trick movements. It should, however, be emphasized that in order to build up occupational therapy as a really useful and reliable method for accelerating rehabilitation, a carefully elaborated organization and a plan of indication, time of onset and duration, have to be established. These, as far as I know, have not yet been developed in regard to peripheral nerve lesions. Although N. A. Haworth and E. M. Macdonald (1940) published a very suitable list of suggested occupations in peripheral nerve lesions and some authors let their patients work with suitably altered tools, a special technique of occupational training is not yet fully formulated, and the various crafts used in occupational training have not yet been analysed and suitably modified from the physiological and psychological point of view. In a median or ulnar nerve paralysis, for instance, all the arrangements for occupational training must be conditioned by the anæsthetic and atrophic state of the skin and subcutaneous tissues. Exercises which can macerate the skin such as with moist clay, must be avoided, also tools producing a permanent and too strong pressure. Therefore in every case clear direction should be given to the occupational therapist about the details of motor, sensory and trophic disturbances and supervision of this therapy by the doctor is of great importance. A close co-operation between doctor and occupational therapist is also of immense value for the mental state of the patients, particularly in overcoming the various mental disabilities due to injury and hospitalization. The latter particularly, should not be underestimated in war time. In every case the occupational therapist should record all his arrangements and observations,

for these can be of great help to the doctor, giving information about the patient's behaviour with regard to the restoration of working capacity.

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PSYCHOLOGICAL REACTIONS TO INJURY

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It is unfortunate but nevertheless true that many members of the medical profession are rarely able to visualize all the needs of the individual whom they are called upon to treat. Probably the commonest example of this failing is seen in the case of the physically disabled. The deformity is in itself so obvious that the surgeon, nurses, friends etc., may direct all their attention and energies towards its alleviation that the question of mental hygiene is neglected. The result is that morbid psychological factors are introduced because of over-emphasis on the purely physical problem.

Something constructive can be offered to compensate for physical handicaps. This may be in the form of adequate recreational facilities, occupational therapy which must be something more than an aid to physiotherapy and which will interest the patient, develop pride in accomplishment and give a feeling of independence. By such means feelings of inferiority and inadequacy, self-pity and resentment against their environment will tend to disappear.

Among cripples who have attained fame are Michael Angelo, Beethoven, Shelley, Ovid, Brahms, etc., while among the crippled who have achieved infamy are Attila the Hun, Kaiser Wilhelm the second and Goebbels.

Lesions of the central nervous system such as birth trauma, encephalitis, etc., which produce physical disability often cause at the same time a disturbance of personality which is not a psychological reaction to the physical disablement at all. The personality disturbance with probable intellectual impairment are the direct results of the cerebral lesion which has caused the physical disability. In the same way in the adult who suffers a cerebral injury or vascular accident, emotional and intellectual disturbance often occur at the

same time as the physical symptoms. Patients with partial cerebral lesions may be much more distressed than those with complete ones. In the latter insight is often lacking and intellectual impairment amounting to dementia may be present. For instance a patient with hemianopia may be very distressed by his disability whereas a patient with a complete central blindness may be quite unaffected by his loss. Most of these patients, both children and adults, not only require the services of an orthopaedic surgeon to attend to the physical deformity but also those of a neuro-psychiatrist.

As to the question of deformities in adults there is the group where patients have lost a limb as a result of an accident and which relatives ascribe as the causal factor in a consequent mental illness. For instance a girl of 25 was said to have fallen under a tube train while trying to enter it and she sustained a laceration of the scalp together with a severed leg. She was an attractive girl, intelligent and artistic and when convalescence from the physical illness occurred she began to be depressed, said people were staring at her and talking about her. Since that time viz, two years ago, she has shown signs of an insidiously developing schizophrenia and it is not at all unlikely that her psychotic illness had started before the so-called accident which may have been in the nature of a suicidal attempt. It is wise not to include this type of case about which there is some doubt as to the relationship between the physical injury and psychological reaction but to study those patients who are apparently normal before the accident producing the physical disability and who develop abnormal mental attitudes afterwards. Many such cases of disability and deformity are seen now-a-days as a result of war injuries and among the commonest are loss of limbs, blindness and facial disfigurement.

It is not proposed to discuss the psychological disturbances which may occur as a result of sepsis, exhaustion etc., and which may take the form of delirious states, toxic confusional reactions and which are not psychological reactions to the physical deformities.

The first adjustment which loss of a limb entails is to that of the phantom limb. This may be regarded as an hallucination occur-

ring in persons with a normal mental setting. The patient, although the limb appears to be very real, has insight into the fact that the limb is illusory in nature. By subjective perception the limb is perceived as a real one while by objective perception this impression is corrected mainly as a result of visual impressions. A peripheral theory for the phantom limb assumes that the phantom sensation originates from excitation of nerve ends in the scar and anæsthetization of the stump has abolished the phantom limb which returns when the anaesthesia passed away. The cerebral theory maintains that the limb is still represented in the total body image. Head showed that the phantom limb disappeared after injuries of the posterior central convolution and parietal region of the brain. Phantoms are missing in congenital absences of limbs and this is thought to be due to the fact that they have never been represented in the body image. Again the fact that the arm is much less marked in phantom limbs than the hand may be due to the fact that central representation of the hand is much more extensive than the arm.

Phantom limbs which are not always present may appear immediately after amputation or not for some time. The limb usually feels the same size as the normal one while feelings of irritation and itching and alterations in temperature are not uncommon. For instance one patient with an amputation through the lower third of the thigh complained of continuous itching below the heel and a feeling as if hot water were being poured down the leg. Pains and cramps in the phantom are not uncommon, the patient often complaining that the toes or fingers are bent in uncomfortable positions. A characteristic of the pain appears to be that it is most marked and persistent where the patient has had a painful wound or scar before amputation. For instance, a patient who had had a wound of the knee with subsequent amputation of the leg felt this painful wound of the knee for some time, while another patient whose leg was amputated for senile gangrene was kept awake at nights by a pain in the big toe which had been very painful before amputation. A woman whose eye had been removed some years before because of severe corneal ulceration which had been extremely painful

developed a painful phantom eye which persisted for some time. On the other hand those patients who are, like many air-raid casualties severely shocked at the time they have been injured and have not had to endure for some considerable time the pain of chronic ulceration, gangrene, etc., do not appear to be troubled so much by pain in the phantom limb which, however, is still definitely present. On the other hand some patients only have phantom limbs when they have pains in them. When an artificial limb is fitted this may be identified with the phantom and may be animated although the latter may be felt to be independent of the position of the body. The adjustment to the phantom limb takes place fairly rapidly although the pains and cramps in it may give rise to periods of insomnia as they are usually more marked at night. In some cases the insomnia and resulting fatigue tend to produce mild temporary anxiety states.

When the patient is ready for discharge from hospital he now has to adjust himself to his new circumstances. The degree of adjustment which the patient makes depends on a number of circumstances. The younger the person, as a rule, the better the adjustment provided that environmental factors are favorable. It is found that after the prime of life adaptability is much more difficult although even in younger persons other factors must be taken into consideration. For instance in the case of a young attractive unmarried girl the loss of a leg or facial disfigurement may cause a much more difficult task in adjusting than the loss of an arm, whereas the loss of an arm in the breadwinner of a family who is a manual laborer would be more difficult to adjust to than the loss of an eye or severe facial disfigurement. Here again it is obvious that rehabilitation for the latter in the form of vocational training for some other form of employment and psychological guidance, together with useful creative employment for the former will help to make the mental adjustment more easy.

The previous personality of the patient is also an important factor in the psychological attitude towards an injury. Those who previously showed evidence of neurotic traits are more likely to

show abnormal reactions than the stable type of individual. This is well typified in the case of a soldier of 26; admitted on 22.6.40 with a compound comminuted fracture of the left tibia and fibula complicated by gas gangrene. The left leg was amputated below the knee. He was quite cheerful while in hospital, made a good recovery and was discharged to Queen Mary's Hospital, Roehampton for fitting of an artificial limb on 16.4.41. He is now at home and doing his previous work of accountancy with the same firm. He is morose, depressed and apathetic and makes little attempt to interest himself in things generally. It appears that he has always been spoiled by his mother at home, that he is selfish and self-centred and now his mother is very over sympathetic and over-protective and she is always giving in to him. This is just the right type of environment to produce such a state of despondency in a spoiled and pampered individual who obviously requires a firm but kindly attitude to remove the feelings of dependence and hopelessness.

The comparatively few amputation cases which have passed through this hospital have made good adjustments and are in employment or doing their housework, apart from one who passed through a severe phase of depression from which he made a good recovery and the other case already mentioned. None of them show any feelings of resentment unless sympathetic strangers try to help them while only one shows any signs of self pity.

It must not be assumed however that only patients with total or partial amputations are the ones liable to develop abnormal pyschological reactions as very often severe or even minor injuries may be opportunities for patients to perpetuate symptoms for some unconscious motive and for which there is no longer any organic basis. This is seen especially in war time where service cases who have been wounded continue to have painful scars or stiff joints long after physical factors have ceased to play a part. Very often this is the result of a hysterical prolongation or fixation of symptoms, the motive for the symptoms being that they keep the patient in hospital or at any rate out of active service. These neurotic reactions resemble the compensation neuroses of peace time in that the symp-

toms may improve or disappear when the ends are achieved and an adequate pension has been provided. Hysterical exaggeration of symptoms may also occur even when the physical factor is still operative, all these hysterical symptoms arising out of the patients' previous personality, the number of such cases however being comparatively few. Psychotherapy in the form of persuasion, suggestion or hypnosis should be started immediately as the longer the symptoms are allowed to develop the more intractable do they become and the more difficult are they to remove.

These symptoms are not consciously produced and the patient does not realize that they are functional in origin. In fact were such symptoms conscious in origin they would express a deliberate intention on the part of the patient to achieve some notice which would help his ends such a condition being malingering. Often conscious and unconscious notices are combined and the malingerer may easily persuade himself of the reality of his symptoms.

The following case illustrates the neurotic reaction to a physical injury and at the same time partially reveals the underlying psychopathology. A married woman aged 34 was admitted to hospital on 24.11.40. She was travelling in a bus with a girl friend during an air raid when a bomb fell near. The patient felt a severe pain in the left arm and also her friend lying on her and on looking round she saw the battered blood stained face of her friend who was dead. She sustained a comminuted fracture of the left ulva and a punctured wound of the neck. The arm was cleaned, the fracture set and the limb put up in plaster. Union and alignment were good and when the plaster was removed massage and remedial exercises were ordered. The patient refused to cooperate, became aggressive towards the masseuse and yelled with pain. It was noticed that when attempts were made to move the arm the antagonists contracted at the same time and went into spasm. Manipulation was attempted on 29.3.41 with little result. The arm was abnormally wasted but no neurological signs were present. She was seen by a psychiatrist as it was considered that a functional element was present. She was diagnosed as a hysterical contracture and was

given intravenous sodium amytal in an attempt to relieve this and also to make her more receptive of suggestions to aid movements. This was unsuccessful and when an attempt was made to straighten the arm she called the doctor a brute, screamed and wept copiously. As it was considered that there might be some underlying organic cause also her arm was again manipulated on 29.4.41 when many adhesions in both the shoulder and elbow joints were broken down. She was again given amytal and on this occasion movements of the arm took place. She was given therapeutic talks and left the hospital improved on 11.5.41.

The relevant psychiatric history was as follows: The mother had a withered arm which resulted in her obtaining more sympathy from her husband than she would otherwise have done. The patient had previously had a good personality with no neurotic traits but her husband was a bully and went with other women. He was only kind to her when she was ill and he gave the sister of the ward the impression that he was not anxious to have her home. In addition the patient's children had been evacuated to Devon and although she wanted to join them there she was afraid to leave her husband as it would allow him more liberty with other women. There was also the suggestion that the friend who was travelling in the bus with her and who was killed was one of her husband's girl friends. The unconscious motivation for the hysterical illness therefore appeared to be the fact that her husband was only kind when she was ill, guilt feelings associated with the death of her friend owing to its probably being associated with an unconscious wish for this to occur as a result of her husband's relationship with her, the conflict over wishing to join her children and the mother having a withered arm which served as an example to her.

This case demonstrates very well the mixture of neurotic and organic symptoms together with the underlying psychopathology. It should be emphasized that any physical injury which is not making satisfactory progress in the absence of any physical signs to account for the condition or where it is definitely suspected that there is a functional component the services of a psychiatrist should

be called upon at once in order that any underlying factors for such a neurotic superstructure may be exposed and dealt with.

It must be emphasized that a patient may give an impression of having made a good adjustment while in hospital and that after being at home for some time, as quoted in the second case, psychological difficulties occur. A wise precaution would be to have all such patients seen by a psychiatrist while in hospital to ensure that there are no personality difficulties etc., and also to have a social report on the environment to which he is going in order that unsuitable influences can be removed or another more suitable environment found.

Before concluding I should like to say I have recently had an opportunity of seeing ex-service men disabled in the last war. Many of these men have been leading invalid lives for 25 years as a result of fractured spines etc., and the outstanding characteristics of their mental state are resignation and apathy, self-centredness and a tendency to talk about themselves indefinitely. There is however a definite esprit de corps and feeling of comradeship, they are willing to help each other and the home whenever they are able, they will do handicrafts if encouraged but if *ordered* to do anything or strict discipline is enforced they become difficult and obstructive.

Finally it appears that cases wounded in this war likely to be permanently disabled are already being sent to such homes and hospitals. This seems to be a great psychological error as these men quickly realize that in another twenty years they are likely to be like the others and they rapidly become depressed, refuse to stay, and are often extremely difficult to manage. Separate homes when the number warrants it should be provided, and until such time arises, beds in other hospitals could be allotted where they would receive psychological encouragement by the admission and discharge of other patients.

MALINGERING

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A malingerer has been defined by Wechsler (1935) as one who, 'consciously and purposely, in order to deceive, to evade responsibility, or to derive gain, feigns illness and voluntarily tries to reproduce signs or symptoms which he really does not have, or extravagantly exaggerates minor ones which he has.' A shorter definition is that of Lord Justice Buckley (quoted by Collie, 1917): 'One who is not ill, and pretends that he is.'

Malingering may assume any one of the following forms: (i) Invention. The symptoms are fraudulently assumed by a patient who was previously free from any such complaints. (ii) Exaggeration. There are some genuine symptoms, but the patient fraudulently makes these out to be greater than they really are. (iii) Perseveration. Symptoms were once really present, have ceased to exist, but are fraudulently alleged to continue. (iv) Transference. Genuine symptoms are present, but the patient fraudulently ascribes these to some cause which, if proved, would entitle him to some benefit, knowing that in fact his condition is of a different origin.

Malingering is quite rare in ordinary medical practice. It is only in circumstances of exceptional strain that cases become at all frequent. Very few persons set out deliberately to practise this type of fraud, and feigning of illness is often no more than an attempt to escape from an intolerable situation, perhaps in an individual whose moral principles, including his sense of responsibility, have never been highly developed.

Soldiers and other Service men may seek to evade the dangers and hardships of war, or even the dull routine of barrack life, by inventing or exploiting illness. There is nothing to distinguish such cases from other instances of malingering except that the particular form

of disability assumed may be determined by special opportunity, e.g. self-inflicted gunshot wounds, or poisoning by cordite or by picric acid.

The influence of example may lead to small epidemics of such conditions as dermatitis artefacta; a malingerer who has had some success may have many imitators amongst those living in close contact with him. Costedoat (1933) called attention to the existence of establishments near military camps or barracks in which an unscrupulous chemist or other person was prepared, for a small payment, to induce an abscess by subcutaneous injection of an irritating substance.

Diagnosis

A diagnosis of malingering is often made as a result of an examination which is incomplete on account of the obstructive or offensive conduct of the patient. Such an attitude on the part of the patient should call for a special effort to reach an understanding, and the practitioner, however justly indignant he may feel, should be careful not to commit himself to an opinion which might be challenged on the ground that it was no more than a hasty first impression of a case which was never properly investigated. Full allowance should be made for any prejudice which the examiner may entertain against the class to which the patient belongs; a medical opinion should not be influenced by racial or any other unscientific antipathies.

Malingering is not a disease but a species of fraud, and it might well be considered that a medical man as such has no special qualifications to decide whether his patient is guilty of fraud. In any case, if he is asked in Court whether the claimant is a malingerer, it would be quite proper to rely that this appears to be a question for the Court. No witness is allowed to express an opinion in a matter on which he is not an expert (see *Medical Witness*). It will, of course, be very suggestive if the patient's complaints are withdrawn, or substantially modified, as a result of questions or tests; an examination may point conclusively to some

active interference on the part of the patient, and the practitioner may then be required to state whether the condition is voluntarily and consciously produced or is a manifestation of spontaneous disease or accidental injury.

The conditions which are most likely to be confused with malingering include the following:

(i) Mistake. The patient's complaints may appear unjustified or even absurd because, owing to lack of education, he uses inappropriate words to describe his condition; he may say that a limb is 'paralysed' because he thinks that this term covers weakness, ataxy, or abnormal sensation in the part. He may appear to exaggerate, merely because he is accustomed to express himself in superlatives. He may simulate paralysis only because he holds a mistaken belief that the injury which he has sustained must necessarily lead to such an effect. He may perseverate solely from mental inertia, or because someone has told him that he will never recover, and he has accepted this unwise and mistaken opinion without question. Even intelligent people may wrongly believe that if an effort is painful it should always be avoided, so that the exercise of stiff muscles or joints is indefinitely postponed.

(ii) Psychoneurosis. This implies that the patient adopts a morbid mental attitude towards his problems. The clinical features of the condition are described under the title *Psychoneuroses.* The neurotic temperament is very common, but is just as likely to be accompanied by a high sense of duty and responsibility as by an inclination to resort to fraud.

(iii) Psychoses. The onset of serious mental derangement may be marked by complaints of symptoms for which no adequate physical basis can be found. (See also *Psychoses.*)

Local Manifestations of Malingering

1. Cardiovascular System. — Drugs, such as digitalis, belladonna, and thyroid extract, may be taken in order to produce circulatory disturbances. A diagnosis rests upon the discovery of the characteristic effects of these drugs, upon their detection in the

patient's possession or in his excreta, and upon the disappearance of the symptoms after a short period of isolation of the patient.

2. Respiratory System. — Epistaxis may be provoked by self-inflicted injury to the nose; examination will show the effects of such injury. Spontaneous nose-bleeding is usually associated with a small ulcer on the front of the nasal septum.

Patients have been known to produce a specimen of sputum containing tubercle bacilli which they have obtained from other patients; this fraud can be detected only by rigid supervision.

Haemoptysis is easily simulated, and the recognition of such a case may offer considerable difficulty and require prolonged observation of the patient.

3. Digestive System. — Dysphagia, vomiting, haematemesis, and abdominal pain may each or all be complained of with fraudulent intent; the absence of physical signs is by no means conclusive, but — as in so many cases of malingering — the diagnosis may sometimes be made by closely questioning the patient about his symptoms, this leading to confusion and self-contradiction.

During the Great War some cases of jaundice were recognized as having been self-induced by taking picric acid; a single dose of 5 to 10 grains is followed by the appearance of jaundice in about twelve hours, reaching its maximal intensity in about twenty-four hours and clearing up in about a week. Although the jaundice appears to be due to damage to cells in the liver, it is not as a rule accompanied by any increased fragility of the red corpuscles, bradycardia, or pruritus. Catarrhal jaundice can be excluded from the diagnosis by the absence of fever, and spirochaetosis icterohaemorrhagica (Weil's disease) by the absence of leptospirae. The origin of the condition can be demonstrated by the discovery of picramic acid in the urine; this appears within a few hours of ingestion and persists for about a month; it can be detected in dilutions up to 1 in 20,000.

4. Excretory System. — Albuminuria may be feigned by the addition of egg-albumen to the urine after voiding; this may be recognized by finding undissolved strands of albuminous material in

the specimen. The ingestion of an excessive amount of raw egg-albumen (e.g. six eggs) may lead to the elimination of this substance unchanged in the urine; no such effect is obtained if cooked eggs are taken.

Sugar may be added to a specimen of urine in order to stimulate diabetes mellitus; in such a case the blood-sugar will be normal, and the added sugar may be shown to be saccharose.

Haematuria may be provoked by self-inflicted injury to the urethra; this will lead to the passage of blood independently of micturition; examination with a urethroscope will show the source of the bleeding.

Urethral discharge was simulated during the Great War among both French and British colonial troops by injection into the urethra of condensed milk, and cases even occurred of men deliberately infecting themselves with venereal disease.

5. Skin. — Dermatitis artefacta may be indicated by the situation of the lesions — usually within easy reach of the right hand — and by their character, e.g. linear abrasions in sets of four, caused by the finger-nails or by a fork. The application of caustic liquids to the skin may sometimes be betrayed by a streak of inflammation set up by a drop of the liquid running down from the site of application. Lesions may be produced by biting and sucking the skin (see Vol. III, p. 617); these may be suspected if the site is within reach of the mouth, especially if marks of the teeth are apparent. The application of an occlusive dressing, such as plaster of Paris, will usually be followed by rapid healing of the sores, but others may then appear on parts of the body not so protected.

6. Eye. — Conjunctivitis may be induced by rubbing the eye, or by the application of irritants such as tobacco or pepper; these substances may be recognized by their microscopical appearance. The resulting disease is usually limited to the lower part of one eye, and bacteria are absent or few in number in the discharge.

Miners' nystagmus has acquired considerable importance in Great Britain since 1906, when it was included in the schedule of industrial diseases giving a right to workmen's compensation. The number

of claims increased from 460 in 1908 (the first full year in which this statute became operative) to 11,083 in 1931, when such cases accounted for over 57 per cent of all claims in respect of industrial disease. As the law now stands, based on the Workmen's Compensation Act, 1925, Schedule III, 19, a man may recover compensation in respect of miners' nystagmus although he is not a miner and has no nystagmus (i.e. oscillatory movements of the eyes). Although most miners over middle age have nystagmus, only a few complain of any symptoms, and disability is then often due to associated conditions, such as blepharospasm and photophobia, which may in some cases be feigned. Culpin (1931) and others have shown that the real cause of disability in most cases of miners' nystagmus is a psychoneurosis.

A false allegation of impairment or loss of vision, particularly if referred to one eye only, may often be recognized by the use of a trial-frame which will enable the examiner, unknown to the subject, to occlude the sound eye. The patient's response to tests of visual acuity will probably be inconsistent with any local defect.

Complaints of night-blindness may be made with a view to evading disagreeable duties, such as military operations, at night. Such a case may be tested for visual acuity with progressive decrease of illumination, as by the use of smoked glass trial lenses. In a true night-blindness the reduction of visual acuity in this test is greater than with a normal subject; the simulator will probably show a normal rate of reduction, believing that his disability affects him only at night and not in the artificial conditions of a well-lighted consulting-room. To a normal eye, tested with progressively decreased illumination, the colour red appears black earlier than the colour blue; this order is reversed in night-blindness (Pollock).

7. Ear. — Complaints of aural discharge should arouse suspicion if the external auditory meatus contains wax, particularly if the tympanic membrane is intact.

In alleged partial deafness the consistency of the symptoms may be tested by ascertaining whether a watch is always heard at about the same distance in successive tests. When the deafness is referred

only to one ear, the patient may be fitted with a stethoscope, through which the examiner, standing behind the patient, addresses him; by compressing each tube of the instrument in turn, out of sight of the subject, it can be ascertained whether his complaints are consistent.

If the patient's attention is distracted, he may answer a question which he would not have heard if he had been as deaf as he represents himself to be. He may show, by a shudder or a blinking reflex, that he has become aware of a sudden noise, but it must be remembered that it may have been by transmission of vibration through the floor or by some other physical contact with the source of the sound.

Deaf people usually come to rely to some extent upon lip-reading to assist them; this will be suggested if the patient is seen to be watching the examiner's lips when addressed; proficiency in lip-reading indicates that the deafness is of long standing — a point which may be important if the deafness is attributed to a recent accident. Suspicion may arise if the patient claims to depend on lip-reading but avoids the errors common in this practice, such as confusing the sounds of the letters B, P, and M.

If nerve deafness is caused by an injury, e.g. a fractured skull, then the functions of the vestibule are almost always also impaired or lost, and there is often evidence of damage to other cranial nerves, particularly the seventh.

8. Nervous System. — Complaints of paralysis, anaesthesia, or abnormal states of mind are among the commonest manifestations of simulated disease. A correct diagnosis calls for an extensive knowledge of the functions of the nervous system and of the possible effects of injury or disease on these functions. The problem is complicated by the fact that physical signs are often not demonstrable in the early stages of nervous disease or in cases of injury such as concussion. Complaints of headache and giddiness following a head injury may be clearly related to conditions which indicate a disturbance of the cerebral circulation, for example, when the symptoms are brought on by stooping or by sudden change of posture.

a. *Paralysis.* — Paralysis of organic origin is almost invariably accompanied by a change in muscle tone; this may be recognized by the following tests:

(i) The tendon-reflexes are usually normal in cases of simulation; they may be voluntarily exaggerated, but the latent interval and the amplitude of the response cannot be maintained constant.

(ii) With the patient lying in a relaxed posture on a hard surface, the muscles of a paralysed limb may be seen to 'spread,' so that this limb appears wider and flatter than its fellow; this may be seen most easily in the thigh — Heilbronner's sign.

(iii) Flaccid paralysis of a limb leads to abnormal mobility in its joints; thus, the range of flexion at the elbow is increased, as is the range of flexion at the hip with the knee extended.

(iv) If the paralysis in a part is incomplete, the stronger groups of muscles determine the attitude; for example, the ankle may be held in plantar flexion in cases of lead poisoning or of damage to the external popliteal nerve, and in a case of facial palsy the mouth is drawn towards the unaffected side.

(v) If a patient with an organic hemiparesis is asked to walk sideways he will do so more easily towards the affected side than away from it — Schüller's test. In walking he circumducts the weak limb and does not merely drag it, as is apt to be the case in simulation.

The electrical reactions of muscles are normal in simulated paralysis, and muscles which are alleged to be weak may be brought into strong contraction if the patient does not realize that he is doing this, as when he is resisting passive movement or lifting a weight while the examiner is 'helping' him by grasping the patient's forearm with both hands.

b. *Contracture.* — Damage to the upper motor neurones causes an immediate flaccidity of the associated muscles; this is succeeded after an interval by hypertonicity of gradual onset, which may ultimately be followed by permanent shortening due to replacement of muscle tissue by fibrous tissue. A simulated contracture presents none of these features as a rule, is difficult to maintain without

fatigue, varies in degree from time to time, and generally increases during examination; the approach of the examiner may induce a general stiffening of muscles not concerned with the site of the complaint. The sudden disappearance of a contracture or of a paralysis under the influence of suggestion may indicate the diagnosis.

c. *Anaesthesia.* — In cases of simulated anaesthesia not only may the region stated to be affected, e.g. 'glove' or 'stocking' area, be such as to raise a presumption against an organic basis but the type of disturbance may also be of diagnostic significance. Dissociated anaesthesia is the rule in genuine cases but the exception in those of simulation. The malingerer is seldom aware of the existence of a condition in which one form of sensation is lost and another retained intact in the same area, whereas this is what usually occurs when the disturbance is due to injury or disease. Severance of a cutaneous nerve causes loss of all sense of touch in the affected region but leaves muscle sense unimpaired; syringomyelia leads to loss of the appreciation of pain, heat, and cold, but not of touch; tabes dorsalis may be associated with gross disturbance of postural sense but of no other form of sensation. Complete loss of all forms of sensation in a part can follow injury, but only when this is very severe, as in crushing of the spinal cord, and can hardly occur without unmistakable physical signs apart from the sensory loss.

In examining a case of alleged anaesthesia it is important not only to test for more than one type of sensation but to make full allowance for lack of co-operation of the patient, due to inattention, fatigue, poor intelligence, or mental inertia. The effect of the last named may be observed if tests of sensation are made from the anaesthetic region towards a normal area and then repeated in the opposite direction; the line of demarcation will often be found to vary slightly, but constantly, between the two directions.

d. *Pain.* — In many cases the patient's only complaint is of pain. If this is severe, especially if it comes on in sudden attacks, it will usually be manifested by such physical signs as dilation of the pupil, flushing, sweating, pallor, acceleration of the pulse-rate, and rise of blood-pressure. All these effects may, of course, be no more than

signs of fear in a patient who is afraid that the tests to be applied will be painful. Inquiry should be made about the circumstances which bring on the pain, e.g. exertion in angina pectoris, jolting in renal colic, chewing in trigeminal neuralgia, taking food in peptic ulcer, and stooping in cerebral compression. The examiner must rely on his knowledge and experience to guide him to the cause of such pain as is complained of, bearing in mind that it is just as important to obtain the fullest possible history and description by the patient of his symptoms as it is to make a thorough physical examination. If the complaints appear unreasonable or inconsistent, it may still be necessary to postpone a decision until further observation can be made, with a view to obtaining evidence either of still greater discrepancies or of the existence of some condition which affords a satisfactory explanation of the apparent anomaly.

e. *Insanity.* — Ever since the classical case of King David, who 'feigned himself mad' in order to escape from a difficult situation, a similar device has been adopted from time to time by the resourceful seeker after personal advantage. A prisoner who pleads insanity in a murder trial usually has sufficient good sense to leave his counsel to make what use he can of this plea; any attempt on the part of the accused to give an exhibition of insanity in Court is unlikely to succeed. It would, in fact, be extremely difficult for anyone but an expert psychiatrist to simulate insanity with any hope of deceiving such an expert. The malingerer usually overacts his part to such an extent as to make his imposture unmistakable.

f. *Fits.* — The seizures which occur in major epilepsy are often simulated, but the attempt is usually so clumsy as to afford little difficulty in detection. In taking a history in a case in which 'fits' are said to occur it is particularly important to avoid leading questions either to the patient or to anyone who may be put forward as a witness of the attacks; the accounts so furnished should be compared with each other and with the known clinical manifestations of disease and injury. Circumstantial evidence should be sought, e.g. soiling of the clothing in alleged incontinence and

signs of injury in cases in which it is claimed that this has been sustained. The malingerer will seldom be content to simulate minor epilepsy or focal (Jacksonian) epilepsy; he will choose the type of attack which appears likely to produce the greatest impression; if he can be induced to 'throw' a fit at the time of examination he will probably give a most convincing demonstration of the true character of his condition.

Malingering may take the extreme form of the deliberate infliction of severe injuries, such as gunshot wounds of the hands or feet; or the patient may cut or scratch himself and rub salt or other irritants into the site. The recognition of such conditions depends on their situation — usually within easy reach of the right hand — and their character and progress under treatment; sometimes he may be detected in the act of injuring himself, or weapons or irritants probably intended for this purpose may be found among his possessions, particularly if he has been admitted to hospital for observation. The healing of a wound may be deliberately delayed by scratching or rubbing it. The insertion of a sheet of tinfoil concealed in the dressings will show whether the wound has been attacked by pricking it through the bandages. The application of plaster of Paris in such a case may be defended on the ground that it is advisable on medical grounds to secure healing of a troublesome lesion.

During the war, 1914 to 1918, an authoritative recommendation was made that malingerers should be treated by a very strong faradic current, the forcible application of which was said to be 'almost infallible.' It was held that the malingerer might stand one or two applications, but quickly recovered under the prospect of a daily repetition. These measures, reminiscent rather of the mediaeval torture-chamber than of a consulting-room, are no longer in favor. The practitioner will have carried out his whole duty when he has examined the case to the best of his ability and reported his findings and opinions to the proper authority, who should be left to take whatever action may be indicated.

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RESOCIALIZATION: THE AIM OF THERAPY FOR PSYCHOTIC PATIENTS

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The term "occupational" which has been in use so many years to denote that form of empirical treatment, most universally used in the care of mental patients, does not appear to the writer to be well chosen. The term has a tendency to narrow one's concept of the purpose of the therapy, with the result that mere occupation of patient is deemed by many to be all that is necessary for his treatment.

Before therapy, of any type, is instituted, it is very necessary to determine first whether or not the disorder is due to organic changes. If so, then the treatment should be rational. However, the majority of patients confined to mental hospitals suffer from mental disorders, for which there is at present, no known cause. It is with this latter group that the writer is specially concerned, and for which the treatment, at least for the present, must be empirical.

The mental patient presents symptoms which are described as behavior disorders. These may be either active or passive but they are always either anti-social or asocial. For one of these tendencies, the patient is deprived of his legal rights and removed from society by commitment to a suitable hospital. At once it becomes obvious that any treatment instituted, empirical as it must be, should be directed at the anti-social or asocial behavior rather than at the symptoms which accompany the socially unaccepted behavior.

The many and varied symptoms with resulting behavior disorders, of mental patients, when analyzed, almost without exception are manifestations of the patient's feeling of insecurity. His removal from society seems to be the most sensible step in his treatment to relieve, at least in part, this feeling. Subsequently therapy as provided by the hospital should have its aim in further lessening of this feeling

of insecurity and to make the patient a socially accepted individual, at the highest level he is able to attain.

All of the activities provided for mental patients in hospitals, whether they are designated as particular therapies or not, play an important part in obtaining the desired end and are therefore an essential part of the patient's treatment. Occupational therapy which reaches the greater number of hospital patients, has rightfully been credited with benefiting the greatest number; however, the term misleads many into drawing a conclusion that occupation itself is the agent producing the hoped for improvement.

Any socially accepted activity in which the patient can be interested and in which he can be stimulated to take part, is therapy. Mental hospitals provide all of the activities of a well organized community of equal population plus the many added special activities, most important of which are the occupational, recreational and physical exercise. These activities make it necessary, for the patients engaged in them, to make contact, which they would not make if they were permitted to remain inactive on the hospital wards.

It is very necessary that everyone, no matter in what capacity, connected with a mental hospital, clearly understands that the aim of that hospital is to resocialize the patient. The conduct, actions and speech of every one in his or her contacts with the patient should be such as to always make the patient feel at ease and secure in his hospital environment.

In order then to make everyone who, because of his connection with a mental hospital feels that he or she is an essential factor in the treatment of the patient, a broader designation of therapy seems necessary. *Resocialization Therapy,* or a designation similar thereto seems to the writer better suited to convey the aim of the treatment for mental disorders. Its use would have the much desired tendency to unify the several therapies and stimulate the greater co-operation of all the persons having contact with hospitalized mental patients, so that the ultimate goal, namely the *Resocialization* of the patient to the highest level of his ability, might be constantly kept in mind by everyone.

PRACTICAL USES OF THE TUBED PEDICLE FLAP

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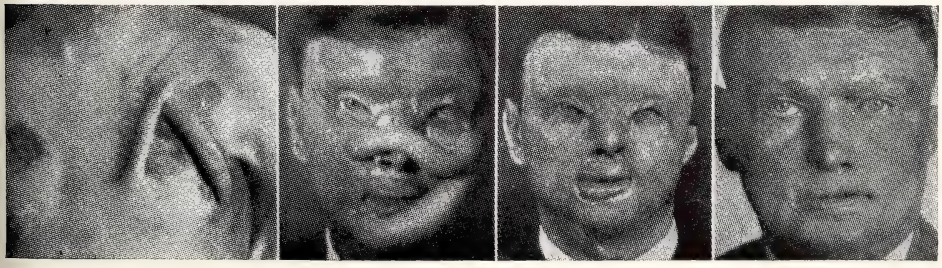
What is a Tubed Pedicle Flap?

It is one in which the parallel edges of the long border of the flap have been sewn together leaving at first both extremities undisturbed, like the attachment of a strap to a bag. It thus forms a tubular roll of skin and fat which develops a blood supply from each end.

What Are Its Chief Advantages Over Other Flaps?

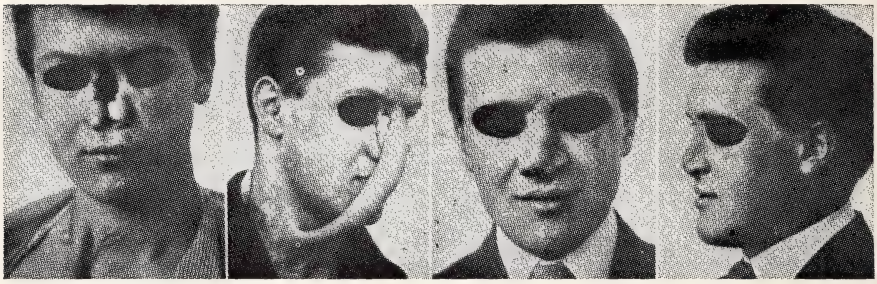
The primary advantage of this flap is that whatever the direction of the original blood supply the first parallel incisions cut off all the horizontally inclined blood vessels so that the flap depends only on the longitudinal anastomosis. In the course of three weeks these longitudinal anastomoses enlarge while the horizontal ones atrophy. When, therefore, either end of the pedicle is cut from its bed the longitudinal blood supply now established is adequate for nourishment by one attachment only. It can therefore safely be transplanted without loss from a distant donor site to the requisite area. The donor site can be sutured or grafted.



A B C D

FIG. 1. A, double tubed acromiopectoral flap. B, primary implantation into face via the wrist. C, flame burns of the face. D, result of treatment.

The secondary advantages of this flap are: (1) Absence of infection and scarring: primary healing of the tubed pedicle flap can be expected in all cases. (2) Flexibility: the tube can be twisted and kinked with a degree of impunity which the non-tubed



A B C D

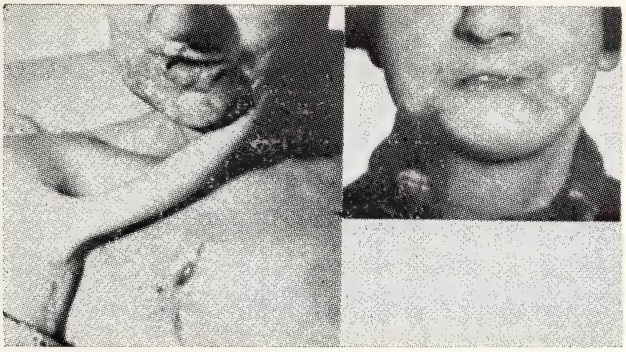
FIG. 2. A and B, total destruction of nose due to congenital lues. C and D, reconstruction by tubed pedicle flap method.

flap could not stand. (3) Convenience to the patient: irksome positions are inseparable from this class of reconstruction, but the tubed pedicle flap by its length and flexibility markedly decreases the discomfort and duration of hospitalization of the patient. As all wounds are closed a minimum dressing ensures a relief from treatment during the waiting interval. (4) Movability: owing to

A B

FIG. 3. Massive reconstruction of cheek, nose and lower lip by tubed pedicle flaps. Result five years after final operation.

the ease and frequency with which this flap is attached to the wrist for a temporary blood supply it can be transported from the abdomen quite easily to any part of the body that the hand can approach.



A B

FIG. 4. Acromiopectoral flap for chin and lip reconstruction.

When Should A Tubed Pedicle Flap Be Used?

Before answering this question it is wise to consider whether a flap or a free graft should be used in the particular case under consideration. An attempt at a detailed guide will be found in a paper by the author.[1] For practical purposes Table 1 below may be found useful, but it is not to be taken too dogmatically.

How is the Repair by a Tubed Pedicle Flap Planned?

Where the Repair is Confined to the Provision of Skin Covering Only.

Example: Repair of one half of the face excluding the eyelid, the nose, and the lips.

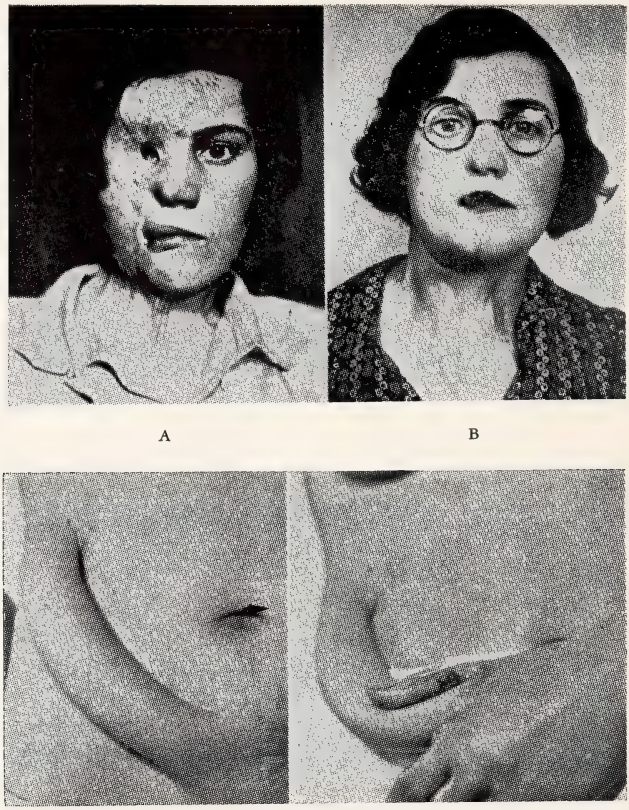
Donor Area: the abdomen.

1. Measure the area and shape of skin required. In making this estimation allow for retraction of displaced normal tissues into their normal position.

2. Cut out in jaconet an exact pattern to fit the estimated raw area caused by the excision of the lesion or scar tissue; corroborate

this estimation by turning the jaconet over onto the sound side and see whether it corresponds to the estimated loss.

3. Wet the jaconet so that it adheres to the flap's final destination.



A B C D

FIG. 5. A, extensive burns of right half of face and neck. B, result of two pedicles to neck and face, with artificial eye piece. C, neck pedicle prepared on abdomen. D, transfer via hand.

4. Bring the opposite wrist into juxtaposition with the lower border of the jaconet model. (It may be as well to add an extra inch to the lower part of the jaconet model in order to have a conveniently mobile pedicle.)

5. Roll the lower half of the jaconet into a tube and place one end onto the back of the forearm near the wrist.

6. Take the jaconet model now held to the wrist down to the abdomen on the same side as the arm and place the untubed part of the jaconet on the outer part of the inguinal region, possibly extending into the lumbar and umbilical regions.

A B C

FIG. 6. Use of tubed pedicle flaps for lower limb defects. A, abdominal flap via ulnar border of wrist to knee. B and C, abdominal flap to lower limb with use of opposite thigh as intermediate host.

7. Remove the jaconet from the wrist attachment and smooth it down towards the pubis along the inguinal region. Puncture the outline with Bonney's Blue Ink. This gives the exact shape and convenient position on the donor site for the flap to be cut.

It will be noted that the jaconet method of planning constitutes the reverse process of the actual repair.[2] (Figs. 3 and 8.)

Example: Replacement of the skin of the chin and lower half of the cheek.

Donor Area: the acromiopectoral region.

1. and 2. Repeat.

3. Place the wetted jaconet model so that its upper border lies along the line of the clavicle and its anterior extremity extends no further than the middle line. It will rest in a general direction

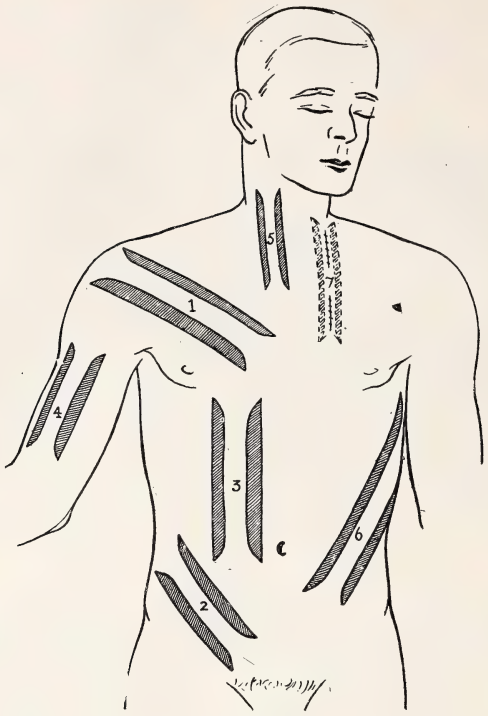


FIG. 7. Common donor sites for tubed pedicle flaps. 1, acromiopectoral and 2, oblique are most common. 7, a scapular flap.

towards the shoulder. An extra piece forming a pedicle not less than 2 inches broad is continued to a point over the acromial process.

4. Test the position by keeping a finger on the acromial end of the jaconet and raising the patient's shoulder by approximating the patient's hand to the opposite shoulder. Incline the head towards the donor site and confirm that the extremity of the flap can easily reach the desired position on the chin. (Fig. 4.)

Example: Extensive losses of the neck.

The method of choice is either an oblique or vertical abdominal tubed pedicle flap transferred to the wrist and carried to the neck. With the patient's hand over the opposite shoulder and with the pedicle attached to the radial border the extremity of the flap can be opened and spread over the defect on the same side as

the transporting arm. Fourteen to twenty-one days later, when this half has united to the neck, the pedicle is freed from the wrist, opened and spread around the circumference of the neck. (Fig 9.)

A B C

FIG. 8, A, old lupus and extensive radionecrosis. B, transport of flap via wrist. C, result.

Alternate methods for the neck are the thoraco-epigastric flap, and the scapular flap running obliquely down the back.

The acromial-pectoral flap is not indicated for this particular repair as it lies too near the region of the repair.

Example: Defects of the axilla and upper part of the arm.

Here the thoraco-epigastric flap is an excellent one and should be better than scapular or acromiopectoral flaps which are taken too near the neighborhood of the joint.

Example: Defects of the anterior chest wall and pectoral region.

The vertical abdominal or the thoraco-epigastric flaps are the most useful.

Example: defects of the thigh.

A long oblique inguinal flap can be designed to give a covering to most defects of the thigh. By flexing the limb the recipient area can be approximated to one or other of the free ends of the tubed pedicle flap; but an intermediate implantation may be required. To settle this question a jaconet model of the flap should again be cut and manipulated into its final position. Sometimes an intermediate implantation into one thigh will enable the tubed pedicle

to be transplanted to a recipient site on any part of the opposite lower limb.

Example: Defect over the knee cap.

The quickest method, apart from a direct flap from the opposite calf, of transplanting a good covering either to the front or back of the knee joint is by making a tubed pedicle flap of the requisite size on the abdomen, and attaching it to the ulnar border of the wrist as a vehicle to convey it to the knee. Again the plan should be carefully worked out with the patient's cooperation and a jaconet model.

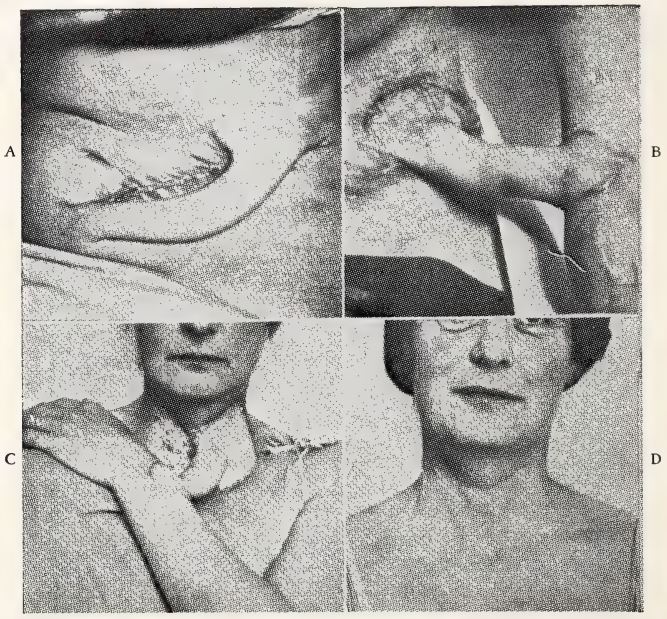


FIG. 9. A, abdominal tubed pedicle flap. B, attachment to wrist. C, first attachment to neck. Note radionecrosis of neck. D, result.

Example: Defects of the ankle and sole of the foot.

When not done by a direct flap from the opposite limb, these defects may be repaired by a tubed pedicle flap carried there via the ulnar border of the wrist.

Example: Massive avulsion of the scalp.

When the bone is not exposed free grafts are satisfactory in this area; but when the bone is exposed it is preferable to cover the raw area of the scalp with a flap. The only flap available is a tubed pedicle flap taken from the abdomen. The design will include two pedicles which together will cover the area.

The pedicles are planned so as to be transplanted via the wrist. After the usual careful measurement two long broad oblique inguinal pedicles are first made. At a second operation these are extended nearly to meet each other in the midline above the pubis. Each of the top ends of the long pedicles is grafted to the ulnar border of the wrist at two separate sittings. As there is extra length of flap to be transported on the wrist, an extra week or two weeks with massage should be allowed before completely freeing the lower end from just above the pubis. The wrist can now be taken with the pedicles which are continuous where they met above the pubis up to the back of the head, and the pubis portion of the flap grafted to the front of the scalp defect. At the end of a fortnight one pedicle can be detached and spread, and at the end of another week the second pedicle may be similarly treated.[4]

Example: Reconstruction of the external ear.

Two uses for a tubed pedicle flap present themselves, firstly to form the covering of the new ear on its posterior aspect, which is best done with an acromiopectoral flap, and secondly to form the margin of the helix. For this purpose a long very narrow pedicle can be made by stages in the neck so that it can be grafted as a free rolled border representing the helix margin.[5,6,7]

Where the Repair Includes Part of the Lining Mucous Membrane.

It must be remembered that in all these cases in which the defects include mucous membrane adequate provision for the lining membrane is even more important than the covering skin. The lining membrane is made by one of two general methods:

1. By grafting whole thickness or thick razor graft skin on that part of the flap corresponding to the mucous membrane loss.[8]

2. By turning in over the area a side branch or prolongation of the flap itself. If the lining has to be made out of the tubed pedicle flap the measurement of the bit required will be double that for the external defect. It should be turned under and the external portion held there by sutures prior to the flap being moved. (Fig. 10.)

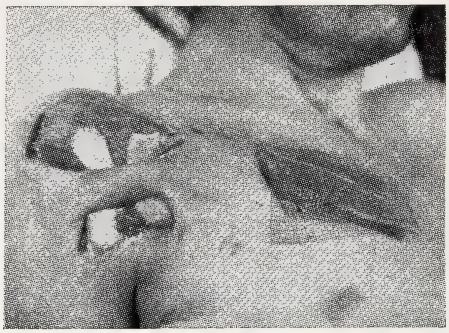


FIG. 10A. Extremity of flap turned under to form lining of new cheek and lip.

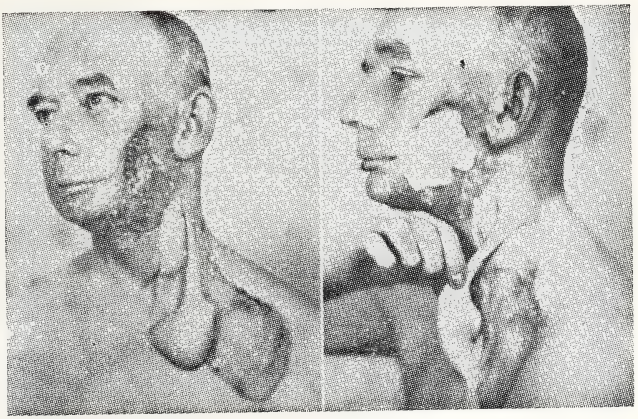
A B

FIG. 10B. Defect following extensive removal for epithelioma. C, result of operation. (Patient referred by Sir Charles Gordon Watson.)

Example: Total rhinoplasty by acromiopectoral tubed pedicle flap.

Common measurements for this particular type of flap are 3 inches down the middle line. At the junction between the second

and third inch which represents the tip of the nose, the cross line consists of 3 inches, being 1½ inches on each side of the tip representing the free alar margin. A line is then drawn from the extremity of this cross line upward to a point half an inch lateral to the beginning of the vertical line on each side. The line is then continued in a curved fashion at the lower end of the flap round to the opposite end of the transverse line. The total area so marked out is in the form of a sector. (Fig. 11.) The curved



A B

FIG. 11. Example of neck-chest pedicle. A and B, extension laterally turned behind flap to form lining of new cheek.

portion of the skin below the cross line is destined to be folded in and under to form the columella and lining of the vestibules. (NOTE: It is presumed that a mucous lining is available for the upper half of the nose.) Design a pedicle not less than 2 inches broad running from the side of this flap over the acromial process. Proceed with testing for position as outlined above. (NOTE: It is sometimes advisable to implant a small strip of cartilage from the ear along the line of the alar margin to give support to the new alae.)

Example: Total lower lip reconstruction by acromiopectoral tubed pedicle flap.

Take measurements as before and design flap of such length

and size as will adequately fill the external skin defect. Plan for the fact that after the pedicle has been made the extremity will be raised and a skin graft, preferably of the full thickness variety applied to its posterior surface.

(Suggestion: While writing this paper a thought has occurred that possibly the reverse process of this type of lower lip reconstruction might be considered, namely to put the flap portion of the repair for the inside of the lip mucous membrane, while the full thickness free graft forms the outside of the new chin and lip. This should give a much more everted type of lip than the first mentioned procedure.)

Example: Hypospadias and reconstruction of the penis.

In cases of hypospadias in which there is a definite deficiency of covering skin such as may occur after unfortunate surgical interferences, a tubed pedicle flap forms a certain and safe covering for the ventral aspect of the penis. The lining may be provided by inturned local flaps, or by free graft applied to the under surface of the extremity of the tubed pedicle flap.

General Operative Technique of the Two Common Tubed Pedicle Flaps (Acromiopectoral and Oblique Abdominal)

First Operation. Outlining the Flap. The jaconet model which has already been prepared has been sterilized with the instruments. The patient's skin should be thoroughly washed with soap and water, and cleansed with alcohol prior to the final cleansing with ether and alcohol on the table. The sterile towels are fixed round the area by painting the skin with mastisol. Local anesthesia, novocaine 1 per cent and adrenalin 100,000, is injected with a Pitcairn syringe throughout the whole area whether a general anesthetic or basal narcosis is used or not. The jaconet model is placed in its predesigned position and dots of Bonney's Blue Ink are punctured into the skin with a needle or sterilized nib around its margin.

Raising the Flap. The jaconet is removed and two parallel cuts are made through skin and fat from one end of the extremity to

the other. The width between these parallel cuts must never be less than 2 inches in the acromiopectoral region, or 2½ inches in the abdominal. The length of the flap made at one sitting should not be more than 8 inches. The depth to which the flap should be raised will depend on the fatness of the patient and/or the advisability of transplanting fat with the pedicle for certain repairs. Speaking generally as regards acromiopectoral and thin abdominal flaps, the method of dissection is as follows: The edges of the flap are picked up with fine hooks and the undermining down to the fascia carried out by dry swab dissection supplemented by blunt scissor dissection. In fat abdomens the flap is raised with an even modicum of fat on its under surface. The broader the

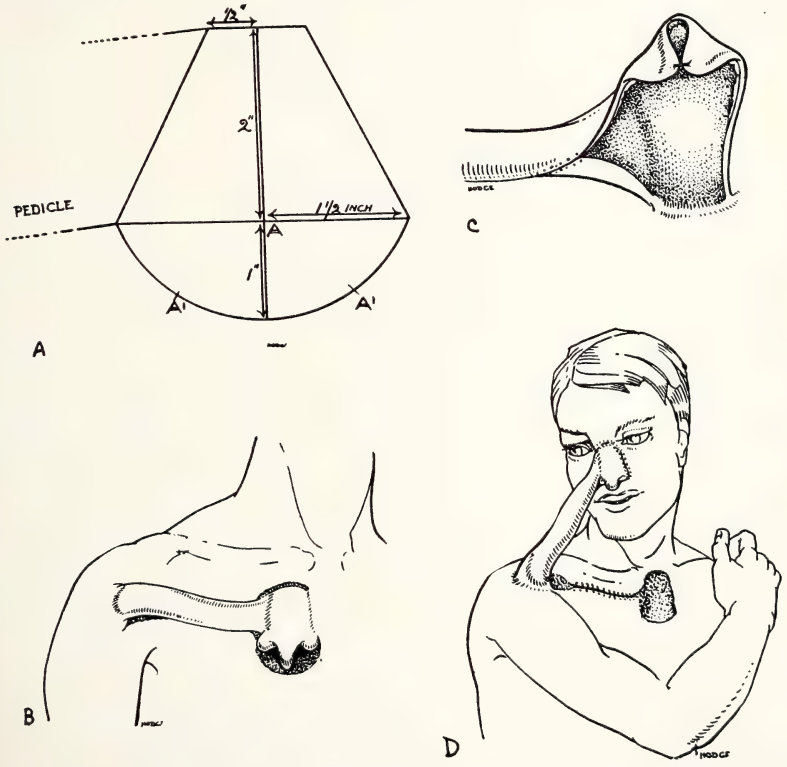


FIG. 12. The plan for an acromiopectoral rhinoplasty. A, pedicle made at first stage. B, pedicle a fortnight later. Lower end of flap turned in to make columella and alae. C, underneath view of this process. D, transference to nose at end of three weeks.

flap the more fat can be included with it. In this type the undermining is best done with a knife. All bleeding vessels are clamped, and any persistent ones on the under surface of the pedicle ligatured.

Tubing the Pedicle Flap by Suture. The first suture is usually placed about 1 to 1½ inches from the extremity of the cut at either end. (Note all sutures must be placed so as to include the minimal amount of skin.) A second suture is placed at the other end similarly and these two sutures held in forceps by the assistant who now presents the cut edges of the pedicled flap towards the operator. Either a continuous end-on lightly pulled mattress suture is now passed to complete the pedicle closure, or in certain cases a subcuticular stitch may be used in its place. For a subcuticular suture an eyeless needle is essential and desirable in any case at any time. (Fig. 12.)

Treatment of the Raw Donor Site. Any fat left behind is removed down to the fascial plane, the borders of the defect are freely undermined for a distance of 2 inches or more on either side by blunt dissection. To assist approximation of these edges beneath an acromiopectoral flap the head may be brought over and the arm raised, and for abdominal defects the knees and back flexed. Three or four deep catgut sutures are used to take the tension off the skin edges and then the edges are approximated by six end-on mattress sutures supplemented by interrupted sutures. The suture is carried out at each end to a point opposite the commencement of the suture of the pedicle. There will now be revealed a double v-shaped defect, one v on the under surface of the pedicle and the other on the raw surface of the donor site lying face to face. This double raw area is approximated by one comprehensive suture. (Fig. 12.)

First Dressing. The incisions are painted with Whitehead's varnish. To take the tension off the repaired donor site beneath the pedicle the skin for 3 inches on each side is painted with mastisol and a piece of lastonet applied direct when the mastisol is tacky. To effect this maneuver the pedicle must be held out of

the way. Gauze dressings are now a
leave the surface of the pedicle in view
The patient is nursed in such a position as to take off all tension from the repaired donor site.

Interval Three Weeks. Second Operation. In an abdominal flap one of the ends of the pedicle is cut across on the original marking and approximated to the radial aspect at the back of the wrist. By pressing the raw surface of the end of the pedicle on the wrist a blood mark will be made of sufficient accuracy with which to judge the incision on the wrist. Half of the blood mark is incised in a circular fashion and turned with its hinge towards the radial border. The raw area on the wrist will now fit the raw area on the extremity of the free pedicle. It should be sutured to the wrist first by two separate stitches at the point where the little wrist flap hinges backwards. Further separate stitches unite the hinged portion of the wrist flap to the pedicle while the pedicle end is sutured to the back of the wrist by a continuous blanket or end-on mattress suture.

Interval Three Weeks. Third Operation. The final abdominal attachment is cut across along the lines of the mark and a special technique employed, in order that as much of the pedicle as possible can be conveniently applied to the recipient area. Not more than half the pedicle should be opened out at this stage and to achieve this two hooks are placed near the central raphe or scar on the under surface of the pedicle and held by an assistant. The pedicle is now held with the left hand underneath it while an accurate and close excision of the central scar of the pedicle, as far as it is intended to open it, is carried out. As soon as the fat is entered the knife is turned laterally on each side and made to follow the circumference of the pedicle. Thus a central core of scar and fat is excised in the process of opening out. The value of the left hand beneath the pedicle is insisted on as by that means alone judgment of the depth of the knife from the skin can be estimated. If an assistant pulls on the scar by forceps, undermining may occur too close to the skin. The flap will now be found to open out into

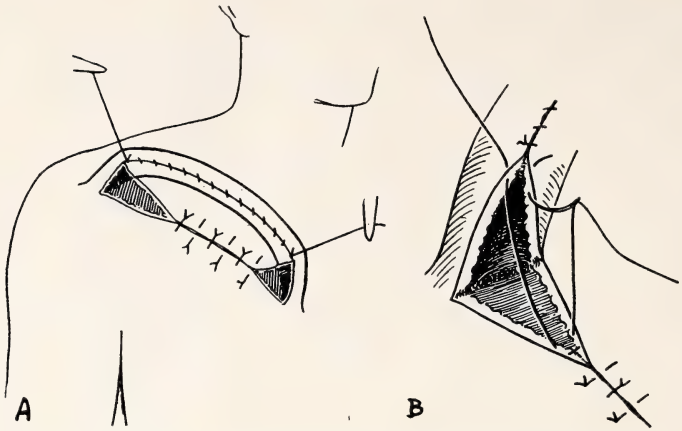


FIG. 13. A, suture of a tubed pedicle. B, special four point suture for opposing raw triangular ends.

its original design. (Fig. 13.) The arm and flap are now approximated to the recipient area and after suitable excision of scar tissue the flap is sutured into its new home. As there is likely to be a small raw area on the under surface of the pedicle between where it is opened out and where it is embedded into its new home a small portion of scar tissue removed from the recipient area can be turned backward on a hinge to cover this small raw area and so protect the pedicle from fibrotic changes.

Interval Two Weeks. Fourth Operation. The scar on the wrist is excised and the pedicle freed from the wrist. The same technique is applied to opening the second half of the flap. The wrist is repaired, and the final scar tissue of the defect removed. The flap is bedded into its new position. Considerable care must be exercised not to interfere with the blood supply of the flap at the junction of its first emplacement and the final portion of the flap.

Acromiopectoral Flap. The operative process is similar but shorter. Frequently however the inner extremity of the flap is required to be broader than the acromial end, as for instance in making a nose. (Figs. 14 and 15.) It is advisable therefore after the first tubing of the main part of the flap to delay the extremity at a sitting a fortnight after the first operation. The portion "de-

FIG. 14. Technique of removal of central scar and excess fat from pedicle. Note control of depth by left hand behind pedicle.

layed" is the expanded end of the pedicle. At the end of three weeks it may be completely elevated with safety. Similarly for the purpose of getting extra length either at the acromial end of a

A B C

FIG. 15. A, design for acromiopectoral flap for nasal reconstruction. B and C, result of operation.

flap, or in an abdominal tubed pedicle flap the pedicle may be extended at the end of a fortnight. This should not interfere with the plan of dividing at three weeks one end of the pedicle (Stage

2). If, however, the flap is very long an extra week should be allowed.

Accessory Treatments

Fixation. Fixation of a newly implanted end of a pedicle whether this is on an intermediate host such as the wrist or at its final destination, requires elaboration to avoid a sudden movement causing stitches to be torn. Under local anesthetic the coöperation of the patient can readily be obtained, but until the patient is round from a general anesthetic sudden movements must be guarded against. When a wrist, for instance, is the recipient of an abdominal tubed pedicle flap, at the end of the operation the elbow and arm should be strapped to the body side while the hand is fixed to the neighborhood of the groin by strapping passing from the back or front, or both, and encircling part of the thigh. One thus obtains fixation in the two directions in which it is possible to move the arm.

In taking a pedicle up to the neck or face via the wrist the following simple technique has found favor. Mastisol is applied to the forehead and a surgical cap fitted over the head, the mastisol giving it adhesion in front. The hand or wrist may now be strapped to the skull cap in a predesigned position. It will usually be found advisable to strap a small pillow or pad between the elbow and the chest wall so as to keep the point of the elbow up. To prevent the elbow going too far up, strapping can be taken down to the side wall of the chest to preclude movement in this direction.

The acromiopectoral flap sometimes entails a severe inclination of the head and approximation of the shoulder towards the cheek. The fundamental piece of strapping to maintain this position is a circular one embracing the head as previously described and passing round the bent point of the elbow. Care must be taken to see that the flap is not under tension on the one hand or its base of blood supply kinked on the other by too close approximation of the wrist

to the face. Subsidiary strapping will probably be required for this adjustment.

Relief of the Irksomeness to the Patient. 1. The extra fixation done on the operation table can often be relieved the next day in suitable patients, and mobility of the wrist and shoulder, elbow and neck, allowed within the limits of the main fixation.

2. Massage and movements are of the greatest importance. All joints immobilized by this process should be treated with massage and movements, either passive or active, at all times during the process of repair. The patient soon learns how much movement is permissible without pulling on the stitches, and within these limits such movements should be encouraged. Frequently a good patient can safely be left with a sandbag as a support for the head, and another for the shoulder, and most of the strapping removed. In difficult positions and with children, it is often worth while practicing the new position of the arm or head for some days before the actual transference is made.

At all times should the mental state of the patient receive the necessary encouragement from those around. All patients should be urged to get up out of bed at the earliest possible moment. When a large incision has been repaired on the abdomen, however, one must be sure that the closure is firm before allowing the patient to get up. By making suitable alterations in their dress, patients may be tempted to put their clothes on even when their arms are attached by a pedicle to the abdomen. Not only should they get up, but, weather permitting, should go out. In reference to this—when multiple operations must be performed on an emaciated or delicate patient and a rest is definitely indicated, instead of taking the pedicle up to the face when one end has been grafted onto the wrist the other end may be grafted onto the same arm and the patient sent away for a suitable convalescence. (Fig. 16.)

Pitfalls and Warnings

Length and Breadth of Tubed Pedicles. A working rule is that no pedicle at the first operation should be more than 8 inches long

by 2 inches in the acromiopectoral region, or 2½ inches in the abdominal region. In thin patients, however, with a good blood supply the pedicles may, if desired, be cut narrower or longer. In fat subjects definite caution should be observed. It is doubtful whether in obese patients the skin has as much volume of blood coming to it as in thin subjects. The same arterial and venous supply is present in both, but in the one has to percolate through a mass of fat as compared with the other.

Crossing the Middle Line. This is always a dangerous procedure and should be guarded against by not allowing the incisions to cross the middle line at the first sitting. At the end of a week it may be perfectly safe to continue the pedicle across the middle line when extra length or width is required.[4]

A B C D

FIG. 16. A, acromiopectoral flap for nasal upper lip reconstruction. B, intermediate stage of attachment to nose. C, flame burns of face. D, result of flap to nose and upper lip (note also free graft to right upper lid). Case unfinished. Requires free graft to left lower lid and hair-bearing graft to right eyebrow.

Placing of the Sutures. If the first suture of each end is placed very near the commencement of the parallel cuts great tension may be produced and the veins occluded at the most important place. An inch to one and a half inches from the end is the usual safe position. It should be tested manually because it will vary according to the amount of fat which is included in the pedicle. Pedicles have been cut with so much fat that it would be impossible to get their skin edges to join without excessive tension and the

fat must be reduced until the edges meet with ease. The exit and entrance points of the suture must be as near the margin of the parallel cuts as possible for two reasons: to avoid stitch marks in the flap, and to prevent contraction of the longitudinal vessels. It is obvious that if a suture is placed ½ from the edge on either side, 1 inch of a pedicle measuring 2 inches is occluded by the stitch, and necrosis is most likely to occur. The best stitch of all for the suture of the tubed pedicle itself is the subcuticular with a fixed stitch at each end, but the end-on mattress and continuous suture are both suitable.

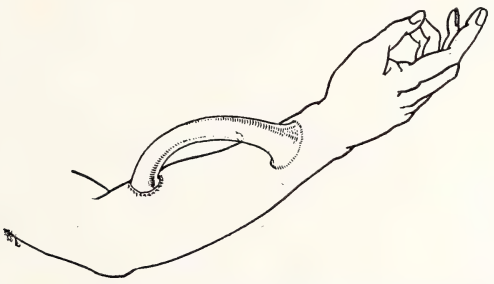


FIG. 17. Both ends of flap embedded in arm for convalescent period. This is occasionally indicated.

Complications in the After-Treatment. These consist mostly of the advent of a silent hematoma. Small bleeding points can leak into the slack tissue of the tube and fail to make their presence known either to the patient or the surgical attendant. Manual palpation will, however, detect a difference in texture between the skin layers in the presence of a hematoma and it can be easily drained. In connection with the picking up of the vessels, when a tubed pedicle flap is turned inside out to inspect it, there is such a kink on the pedicles that the act of presenting the raw surface to the surgeon stops these small vessels from oozing. Consequently it is better to lift the pedicle up gently without twisting and peer underneath for any bleeding points. It is possible that a pedicle may be squeezed by a too tight dressing or a faulty position.

Necrosis. It must be borne in mind that the operator has no

right to risk the loss of any portion of a pedicle flap at any time in its journey. To risk a partial necrosis for the sake of a week or two's delay is surely criminal. Sapiens qui patiens.

TABLE 1

Conditions in Which a Tubed-Flap Is Preferable to a Free Graft

Scalp — Complete avulsion with exposure of bone.[1]

Massive Whole Facial Reconstruction — See Figure 1.

Nose — When the forehead flap method is unavailable or undesired. (Fig. 2.)

Cheeks — In large repairs where soft and supple skin is desirable, and when restoration of contour is also a consideration. (Fig. 3.)

Lips and Chin — In certain cases of total loss following excision for disease; and in certain cases of loss of outside covering caused by burn contractures. (Fig. 4.)

Neck — In all severe losses of the skin of the neck the flap method gives a preferable result to even the most successful whole thickness graft. (Fig. 5.)

Front of Chest — In certain cases when a particularly good cosmetic supple effect is required, otherwise free graft.

Back of Trunk — Free grafts are indicated except in the shoulder region.

Upper Limb — The flap method is specially indicated in the repair of arm or forearm. When the burn or burn contraction is very extensive, and no suitable donor area is available, a more conservative method of treating the contracture by free grafts is indicated. In connection with arm repairs a flap is more usually and conveniently applied by the direct method from the side of the body[2] rather than by the tubed pedicle method; but the long thoraco-epigastric tubed pedicle flap as described by Webster[3] is applicable, particularly for large upper arm defects which include the axilla.

Hand — Most defects of the hand from the cosmetic as well as from the functional point of view may be repaired by free grafts. Where the repair, however, may involve opening a joint the flap method is preferable.

Lower Limb — Defects limiting movements of the knee joint and ankle are best attacked by the flap method. The choice often lies between a direct flap from the opposite limb or the tubed pedicle flap method from the abdomen. This is carried down from the abdomen via the wrist. The choice will depend on a number of factors which each surgeon must decide for each case. Where scarring is undesirable on the opposite limb, or where the defect is gross the tubed pedicle method has the preference (Fig. 6.)

What Are the Common Donor Sites for Tubed Pedicle Flaps?

Oblique Inguinal — This is a very safe flap. No cases of necrosis of a flap of this type can be traced except where it has been grossly maltreated (see Section on Pitfalls and Warnings). As this flap is usually destined for a distant site, such as the neck, one end is transplanted to the wrist which

is used as an intermediate host. The special safety of this flap probably depends on the presence of the thoraco-epigastric vein.[3]

Acromiopectoral — Another very safe flap. Its base lies below the acromial process and its extremity near the midline of the chest. It is particularly suitable in the male for nasal and other facial restoration. It has better quality skin for facial restoration than abdominal skin, and is sometimes therefore preferred by the female, if she does not wish to wear low dresses.

Scapula Region — This is a favored donor site for the back of the neck and axillary repairs.

Front of the Arm — A satisfactory donor site for facial and nasal repairs except that it leaves a very objectionable scar on the arm.

Vertical Abdominal — This is also an excellent flap with its normal blood supply running parallel with it. It can be used via the wrist for transportation anywhere. Or it can climb by the jump method.

Thoraco-epigastric — This is an extension of the oblique inguinal and is particularly useful in repairs of defects of the upper arm including the axilla.[3]

Vertical Neck — This was at one time popular but has largely been superseded by the acromiopectoral. Apart from the scar in the neck caused by its elevation, it is a very convenient method of transplanting good skin to the lower half of the face.

Many Other Donor Sites — have been chosen for pedicles, but in the vast majority of cases either the common abdominal or acromiopectoral flaps are available. (Fig. 7.)

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PLASTIC SURGERY

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Surgical problems of the war have emphasized the role of plastic surgery, accelerated the application of new discoveries to this field and stimulated the organized training of surgeons with the armed forces to handle maxillofacial injuries. The large scale incidence of certain types of injuries has resulted in notable advances in management.

Advances in Treatment Applicable in the Field of Plastic Surgery

It is generally recognized that infections occur in approximately 3 to 5 per cent of clean surgical wounds. Investigations by Hirshfield[1] indicate that the sources of contamination may be (1) the air, (2) the hands of the surgeon and assistants or (3) the patient's own skin. Two sources contribute to the bacteria of the air; (*a*) the respiratory tract of members of the operating team and (*b*) the skin, hair and clothing of the operating team and the patient. These can be controlled to a large extent at the source by irradiation of the air and spraying or replacement methods. The part played by the patient's own skin is uncertain. The fact that there is little difference in the reported incidence of wound infection from clinics in which treatment of the skin differs suggests that it is not important.

In treatment of the local wound, Key and Frankel[2] advocate local implantation of sulfanilamide powder not only in contaminated wounds but in clinically clean operative wounds in which infection is particularly to be feared or would be especially undesirable. Commenting on such a procedure, Key and Burford[3] state that there is no interference with healing and no danger of toxic symptoms and that it is of value in reducing the incidence of wound infections.

For the treatment of infected open wounds, Tompkins, Crook, Haynes and Winters[4] report using pectin as a dressing, with prompt response in clearing up the infection and rapid growth of highly vascular granulation tissue.

The problem of an ideal buried suture material near solution. Aries[5] reports that nylon is well tolerated, has all the good qualities of silk, is stronger and less irritating and does not allow as marked an invasion of its interstices as silk. Localio and Hinton[6] state that cotton is well tolerated also. For best handling it should be boiled ten to twenty minutes and used while wet.

The treatment of burns has been a major problem in the present war. Treatment of the shock is of primary importance, and, according to Tenery and Tenery,[7] far more consideration should be placed on what shall be placed *in* the patient than to what shall be placed *on* him. The intravenous use of plasma in physiologic solution of sodium chloride is very important.

In regard to the external agent used, Wakely[8] finds the application of tannic acid of great value on the trunk, but its use on the face, and particularly on the hands and feet, is strongly contraindicated. Burns of the face are treated with dressings saturated in saline solution, while those of the hand are treated with a saline bath and the use of an aqueous solution of triple dye (2 per cent gentian violet, 1 per cent brilliant green and 0.1 per cent neutral acriflavine). Early skin grafting is undertaken.

Improvement in the coagulating type of treatment of burns is announced by Pickrell,[9] who produces a pliable, translucent, antibacterial eschar by spraying the burn with 3 per cent sulfadiazine (2-[paraaminobenzenesulfonamido]-pyrimidine) in 8 per cent triethanolamine.

An improved noncoagulating moist method is presented by Bunyan,[10] which consists of employment of a rubber envelop through which passes an irrigating solution of 5 per cent sodium hypochlorite (electrolytically produced).

McIndoe,[11] in his treatment of war burns, finds that sulfanilamide powder sprinkled liberally over the burn as a first aid measure aids

in reducing the incidence of subsequent sepsis, and therefore hastens epithelization.

The development in England of centers for management of regional maxillofacial injuries manned by specialist teams has resulted in the undertaking of early skin grafting in cases of burn. There have resulted less pain and care to the patient, a shorter period of hospitalization and far less deformity. Trusler[12] discusses the need of skin grafting procedures as soon as possible and illustrates his methods of grafting. Brown[13] states that the local care of the open wound has for its object the cleaning up of the area as quickly as possible, so that the lost surface may be restored before contractures have occurred and before debilitation and pain have developed beyond control. A graft from one-half to three-quarters the thickness of the whole skin is the most useful in making repair of a raw surface. The deep glands left behind in the derma of the donor site "dedifferentiate" into squamous epithelium and cover the surface in six to eight days. Successive "crops" of this skin may be taken.

Developments Within the Profession

Davis,[14] in his presidential address before the Southern Surgical Association, traced the origins and the development of plastic surgery. Koch,[15] in remarking that the surgeon who transplants skin and subcutaneous tissue is indebted to many men whose experience and discoveries have made possible the results which he accepts today as a matter of course, pays tribute in an interesting and entertaining article to these men. Seltzer[16] gives a brief historical review of the attempts at fulfilment of William Mayo's observation that "every human being has the divine right to look human."

In discussing the educational needs in the development of plastic surgery, Palmer[17] emphasizes that the greatest stress should be placed on training. This can be accomplished by the establishment of residencies under competent instruction and supervision. Other methods are the providing of assistantships under competent men. The ability of the senior surgeon to impart his knowledge and skill

to the assistant and the clinical opportunities provided are major factors in the end result. Postgraduate education is planned to help the practitioner keep abreast of new developments.

Announcement of the membership, aims and purpose of the American Board of Plastic Surgery, Inc., was made in *The Journal of the American Medical Association.*[18] The aim of the organization "is to encourage the study, improve the practice, and advance the cause of plastic surgery, and to grant and to issue certificates of recognition of special knowledge in plastic surgery to surgeons meeting the requirements." The qualifications required are outlined, and an examination in theory and practice of plastic surgery is prerequisite to certification.

Transplantation and Implantation of Tissue: Skin Grafts, Etc.

According to Brown and McDowell,[19] the satisfactory late function of grafts requires (1) enough skin for free movement, (2) moderate looseness, (3) ability to withstand usual trauma and (4) development of normal sensation. Both thick split grafts and grafts of full thickness seem to grow, or at least to stretch out, with growth of the body areas and to permit normal movement if they have been successful from the start. Repair of large surface defects should be made early if possible. Thick split grafts will work satisfactorily in most cases, and several "crops" of such grafts can be taken from the donor area.

Indications for the use of free grafts and pedicled grafts are outlined by Gerrie.[20] When subcutaneous tissue is also required Wilmoth[21] finds the tubed graft best.

In preparing contaminated wounds for skin grafting Veal, Klepser and DeVito[22] found the use of sulfanilamide powder, particularly sulfanilamide (10 per cent) — allantoin (2 per cent) ointment of great value in combating the infection and stimulating the growth of healthy granulations.

The dermatome is an instrument which allows the cutting of precision and uniform skin grafts. Padgett[23] finds that for granulating wounds grafts up to 0.012 inch (0.3 mm.) in thickness will

"take" successfully. On aseptic bases, such as those made for release of scars, grafts up to three-fourths the thickness of the skin may be applied with success. Such grafts allow excellent functional use, are pliable and heal with minimal scarring and contracture.

An excellent monograph on the technic of skin grafting is published by Koch.[24] The management of grafts of intermediate thickness and whole skin thickness, pedicled flaps and combined grafts as related to surgery of the hand is described in detail. The basic principles of his masterly technic can be transferred to the management of grafts anywhere in the body.

Implantation of many and large skin grafts in a debilitated patient may require much more time and reserve than the patient can safely afford. Ellis and Von Wedel[25] find that instead of sewing the graft in, collodion applied to the cutaneous surface of the graft, and to a dried bed, will afford excellent fixation and save considerable time.

Barber[26] notes that the injection of minute particles of dermal tissue beneath the surface of a granulating wound appears to stimulate the healing of raw indolent wounds.

In the treatment of pitted scars, pigmentation and some facial blemishes, Eller and Wolff[27] report that skin peeling artificially produced by physical or chemical agents may secure beneficial results. The exfoliation of skin can be controlled to include only the corneous layer, or more if desired.

The treatment of various conditions by irradiation may cause such damage to the overlying or the neighboring skin that skin grafting is indicated. The late changes in an irradiated field comprise telangiectasis, followed by hyperkeratoses, alopecia, fissures, fibrosis and later loss of the subcutaneous fat, marked endarteritis of the smaller vessels and degenerative changes in the fascia. The most serious of all complications is the development of carcinoma in the skin of the treated area. There is an incubation period between the use of roentgen rays and the development of cancer of from three to eighteen years. The surgical management, according to Daland,[28] consists of broad excision of the involved skin, followed by either

Thiersch grafting or the use of a pedicle flap. Kimball[29] divides irradiation injuries into two types: (1) lesions resulting from a massive dose, with subcutaneous necrosis and pain, best treated by excision and postponement of repair until healthy granulations develop and (2) chronic, long-standing lesions, excision and repair of which can usually be carried out in one stage.

Other conditions requiring similar excision and skin grafting are extensive moles of the face, as reported by Figi.[30]

May[31] lists the three most essential features in achieving a successful transplantation of skin as (1) avoidance of infection, (2) avoidance of hematoma between the graft and the host and (3) complete immobilization of the transplanted area. For transplantation of fat tissue the graft should be two thirds larger than that required to counteract degeneration and shrinkage.

In regard to the transplantation of cartilage, when the graft is taken from the patient himself, it remains alive and forms an organic union with the host tissue. When the graft is taken from another person, it dies, the nuclei disappear, the transplant becomes encapsulated like a foreign body and is apt gradually to become absorbed. The same is true of cartilage preserved in alcohol (Peer) or refrigerated cartilage (O'Connor and Pierce).

Experiments by Young[32] on the transplantation of autogenous cartilage from the rib in dogs, with and without perichondrium, showed that the cartilage remains viable and maintains its size and weight. Dupertuis,[33] experimenting with young cartilage in rabbits, observed that growth of the cartilage occurred. Straith and Slaughter[34] state that in man autogenous cartilage grafts remain as living tissue and neither increase nor decrease. Homografts in human beings may become slightly absorbed, but if the graft is replaced by fibrous tissue, and therefore still maintains its contours, it may constitute a desirable filling substance, even though the original cartilage itself is lost. In 81 of 100 consecutive cases in which homografts were used, recovery was uneventful. In 19 there was some reaction such as redness. Of the 19, the cartilage was retained in all but 4, in which it was lost entirely, and 2, in which it was lost in

part. Thus, 94 per cent of the grafts were classed as successful. On 7 of the grafts a second operation was performed to remove or trim the cartilage when curving or migration had taken place.

Iglauer[35] reports similar good results with the use of refrigerated homografts which were kept in a mixture of 1 part aqueous merthiolate (1:1,000) and 4 parts physiologic solution of sodium chloride.

Peer,[36] in investigating the possibilities of using cartilage removed from the septum during a submucous resection as a source of material for a graft, finds that it survives as a living autograft, just as does cartilage which has been removed from a rib.

Mowlem[37] objects to the use of cartilage implants because such a high percentage show curling or migration and require secondary operation. The iliac bone offers material to be used as a graft which survives transplantation successfully and obviates the objections to cartilage. It appears unnecessary to retain the periosteum or to put the bone in contact with the nasal bone for successful results. Sheehan[38] had also used iliac bone successfully in repair of facial and cranial injuries and recommends it highly.

Malbec[39] reports the use of duralumin as an implant in cases of nasal deformities which is tolerated by the tissues.

Plastic Surgery of the Nose

According to King,[40] in all nasal injuries sustained in childhood a thorough septal examination should be made and correction of any displacement carried out early. External deformity at such a time is usually not evident or is masked by external swelling, but will become manifest with time and increase with age if it is not detected at the time of the accident and corrected.

Metzenbaum[41] classifies as a clinical entity the type of nasal injury in which the blow is severe and directly over the nasal bridge, producing the following changes:

1. A depressed locked fracture of the two nasal bones occurs at about their upper third. 2. The two nasal bones no longer form a V, or a gabled roof, to the bridge of the nose but are driven in between, flattened and

depressed to the level of the upper borders of the nasal process of the maxillary bones. 3. This flattening and depression of the nasal bones between the upper borders of the walls of the nasal processes of the maxillary bones increases with width at this plane, and a stress is transmitted within the walls of the nasal processes of the maxillary bones to the nasal base, resulting in a divergent or outward spreading fracture of both outer nasal walls along the base lines of both nasal processes of the maxillary bones.

His treatment consists in exerting pressure with the thumbs against the two divergent lateral nasal walls until they are forced toward each other into their normal anatomic positions. This procedure narrows the nasal base, and at the same time it causes the upper borders of the walls of the fractured nasal processes of the maxillary bones to spread slightly farther apart, so that the depressed locked lower ends of the nasal bones can be unlocked more readily and elevated without splintering. After molding, an external splint is applied to prevent the formation of hematoma.

In the treatment of the extremely deviated nose which is the result of previous trauma and has healed in that position, it is often necessary to remove a small wedge of osseous tissue on the broad side of the nose before repositioning in the midline can be accomplished. Sparer[42] has simplified the removal of such a wedge by inserting a hemostat onto the bared bone and cutting above and below it for removal of a wedge.

Indications for nasal plastic surgery, according to Cohen,[43] are both physiologic and psychologic. Surgery in this field has reached such a development that the ultimate aim today is to secure as nearly a perfect result as possible. Complications due to poor technic or poor judgment are frequent, while those due to infection are infrequent and rarely serious. In the evaluation of the patient the age factor is of importance. Correction of septal displacements noted early in life can be easily made by replacement methods and will save much subsequent deformity. On the other hand, narrowing or raising the nose is best approached surgically when complete growth has taken place. In the management of specific deformities, such as the traumatic saddle nose, correction is often possible by utilizing the bony and cartilaginous tissue available within the nose.

The method of correcting a deflected hump nose which Cohen uses consists of removing the bony hump at an angle so that the remaining side walls are then of equal length and can be fractured over to the midline.

A rare deformity due to an intranasal granuloma of the sporothrix type is reported by Ortmayer and Humphreys.[44]

In the treatment of cleft lip deformities, the more difficult part of the operation is to secure good correction of the associated nasal deformity. Secondary operation for nasal deformity persisting after an operation for cleft lip is often necessary later in life. According to Cinelli,[45] the nasal deformity is characteristic of this type of malformation. The tip of the nose is flattened; drooping of the alar rim gives the nares a flaring effect, making the base of the nares unduly wide. The septum is usually deviated to the normal side. Surgical correction consists chiefly of remolding the alar cartilages and narrowing the nasal floor. According to Brown and McDowell,[46] correction of the nose in cases of cleft lip may require intranasal osteoplastic reduction in the size of the nose with reconstruction of the lateral cartilages. Secondary repair of the lip may include excision of scars, adjustment of levels and transfer of vermilion border flaps from the lower lip. In cases of double cleft lip, advancement of the columella to give prominence to the nasal tip is often indicated, as well as a dental prosthesis to hold the lip out in full contour.

For some reason a prosthesis to replace part or all of the nose may be necessary for temporary or permanent use. The prominence of the nose requires exacting attributes in the prosthesis to be cosmetically acceptable. Bulbulian[47] finds that the most satisfactory material for such a prosthesis is a latex compound.

Plastic Surgery of the Face

On investigation of the decisive factors in the production of fine linear scars in surgical procedures, Cox[48] concludes that it is not any particular method of wound suture which is important, but rather the relation which the direction of the incision bears to the cleavage

line of the skin. Extrinsic factors influence the originating and molding of the line pattern, but the maintenance is purely intrinsic.

In discussing the treatment of acute traumas of the skin and subcutaneous tissues, Bancroft[49] states that many of the failures in the management of such conditions are due to lack of appreciation of the pathologic process occurring in the subcutaneous fat and connective tissue. The success or failure of the general treatment of contused wounds of the skin depends largely on tissue tension. A hematoma should be aspirated, and when severe relaxation incisions should be performed. One might summarize the problem of primary or secondary closure of lacerated wounds as follows: Primary closure may be attempted if the patient is healthy, the skin is clean, the instrument causing damage is relatively clean and sharp and the patient has been seen well under six hours after the injury. In regard to avulsed wounds, Farmer's method of excision of the avulsed piece, with removal of all fat and resuture into the wound as a free graft, is advocated.

The treatment of war wounds is a problem of major importance. Ivy and Stout,[50] in discussing the emergency treatment of war wounds of the face and jaws, report that the points demanding special attention in the combat area are: (1) arrest of hemorrhage, (2) provision of an adequate airway, (3) temporary reduction and fixation of bone fragments and (4) provision for safe transportation.

The main object in the primary care of injuries of the face and jaws, according to Kazanjian,[51] is to reestablish function of the various tissues of the face and jaws and to eliminate, or at least minimize, the visible deformity. The ideal time for suturing the soft tissues of the face is at least within five to six hours after the accident. Not all wounds of the face are cleancut injuries, ready for suturing. There is a great temptation to repair the lacerated and edematous tissues as soon as possible; yet one must remember that suturing of even mildly infected wounds never gives a good cosmetic result and complications may be caused from too early closure. Late primary suture consists of (1) thorough mechanical cleansing of the wound, (2) application of frequent hot fomentations of boric acid

and (3) maintenance of free drainage of the wound. Experience has shown that even badly infected and bruised facial wounds can be made ready for suturing in from two to ten days by this method. In the treatment of fractures of the jaw early and adequate immobilization is the first principle. The fundamental aim is to bring the existing teeth into their normal alinement. This holds true even if there is a definite gap between the two fragments of the mandibular bone. Management of injuries about the eyelids is particularly important to prevent notches, adhesions and ectropion. Spaeth[52] recommends that the suturing of all through and through tears be made meticulously in layers. To prevent notching, he uses Weiner's method of slightly cutting the lips of the wound crescentically. If possible, vertical lacerations should be inclined away from the perpendicular by using triangular resections in order to prevent notching and to improve the scar line. Other valuable papers on the treatment of maxillofacial injuries are contributed by Owens and Vincent,[53] Ivory[54] and Padgett.[55]

The makeup of the team handling maxillofacial injuries is important. Blair,[56] reporting on experiences in World War I, states that the average dental surgeon has special knowledge of the treatment of fractures of the jaw. The well trained surgeon is skilled in the care of the tissues of the whole body, and by pairing these specialists — the dentist and the physician — into individual working units it is possible to put the care of injuries of the face and mouth on a par with other standardized procedures. Kazanjian[57] also agrees as to relation of the dentist and the surgeon in the treatment of deformities of the face and jaws.

Wartime experience with fractures of the facial bones and jaws is reported on in detail by McIndoe.[58] In commenting on fractures of the middle third of the face, he states there is a widely held opinion that crush fractures in this area are best left alone in the early stages and should be sent for special treatment later. It cannot be too strongly emphasized that this attitude is entirely wrong. To obtain good results, early diagnosis, immediate disimpaction and immobilization are essential.

In reviewing 119 cases of wartime fracture of the jaw McIndoe[59] notes that the causes, distribution and variety differ greatly from those seen in civilian practice and that their management presents new problems. In this series, bombs, mine explosions and penetrating missiles accounted for 45 per cent of injuries; the collapse of buildings produced 13 per cent, while head-on crashes of various vehicles caused 36 per cent. Immediate treatment consists of cleansing the wound, suturing with drainage in cases of compound fracture of the jaw and immediate fixation of the jaw with intermaxillary wires. Later, cast metal splints are highly satisfactory. Extensive loss of bone in the mandible, requiring bone grafting, occurred in 10 per cent of the cases.

Other methods of fixation of the fragments in cases of fracture of the jaw are described by Fish.[60] He utilizes bands placed on some of the teeth as fixation points and attaches an arch wire bucally to hold the parts together. Cap splints have proved to be valuable in the experience of the British, and a masterful illustrated exposition of this method of management is published by McLeod and Shepherd.[61]

The use of intermaxillary elastics in the management of fracture of the jaw is often feasible and allows opening of the jaws and some motion. Strock[62] describes a method he has found serviceable.

For fracture of the maxilla and accompanying fractures of the facial bones, extramaxillary traction and immobilization are often necessary. Bisnoff[63] has constructed a universal head cap to give such support wherever needed.

Fracture of the zygomatic bone is not uncommon in wartime and in present day traffic injuries and is often undiagnosed because of overlying swelling and ecchymosis. In cases of severe injury in which there is also comminution of the anterior and posterior sinus walls, the fragments of the zygomatic bone slip back into the depressed position when the elevating force is removed. In such cases Baxter[64] uses a metal splint wired to the teeth as a basic support for a prop which extends up through the alveolobuccal

sulcus to engage and hold the fractured zygoma in position until a supporting callus is formed.

Reconstructions about the face are often necessary in the treatment of cancer of the face or after the eradication of malignant growths by roentgen irradiation and radium therapy. New[65] presents a surgical clinic on the treatment of such conditions. A clinic on congenital and acquired nonmalignant lesions of the face is presented by Jenkins.[66]

Deformities of the lips often occur in the management of congenital cleft lip, particularly double cleft lips. Cannon[67] recommends using the prolabium for the central portion of the lip in primary repair, so that the wound can be closed with minimal tension and yet have the lip and vermilion border resemble the normal. When the child is 10 to 12 years old, the prolabium can be excised and replaced by a split vermilion-bordered lip flap from the lower lip.

For the loss of more than two thirds of the lower lip in cases of resection for carcinoma or for defects resulting from irradiation, repair is usually carried out by flaps taken from distant points, involving much time and several operations. Transplantation of local tissues can be carried out by May's[68] operation in one stage. The author uses a heart-shaped excision of the tumor. The incisions on either side meet each other at a point behind the central part of the mandible. This point becomes the point of rotation around which two square flaps are turned from the immediate neighborhood.

Some facial defects are best handled by a suitable prosthesis. To facilitate the taking of an agar compound impression of the defect, Kaufman[69] devised a matrix made of brass tubing through which water can be run in order to hasten the setting of the impression material. Bulbulian's[70] researches establish the superior qualities of a latex compound for the average external prosthesis. For the larger restorations, involving body cavities as well, acrylic resin, as used by Munson and Heron,[71] is preferable. One interested in the surgical rehabilitation of patients with deformities of the face and mouth subsequent to the treatment of cancer of these regions can ill afford to miss the superb book by Blair, Moore and Byars.[72]

Plastic Surgery of the Ear

Defects of the ear are congenital or acquired. In congenital defects the auricle may be partially or wholly missing. Acquired defects are usually due to (1) trauma, (2) infection or (3) a malignant growth. Cox [73] repairs partial losses by means of a folded flap taken from the postauricular area. Total reconstruction is carried out by the method described by Pierce. Newman[74] also advocates this method.

According to Greeley,[75] the chief stumbling block in rebuilding a new ear lies in the problem of furnishing an adequate support to the overlying skin. Prior to the more recent procedure the best attempt to supply a supporting framework consisted in the utilization of costal cartilage. A distinct advance has been made by using cartilage from the ear of another person, usually the mother. The sacrifice of maternal cartilage is not as mutilating to the donor as one might think.

A new operation for repair of postoperative mastoid fistula is reported by Lillie and Pastore.[76] The technic is as follows: 1. Initial excision of the scarred edges and liberal freeing of the tissues laterally are carried out. 2. The edges of the wound are split into a V, so that an overlapping subcutaneous closure can be effected. 3. Stay sutures tied over rubber tubing are used to evert the edges and produce even pressure.

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SOME REFINEMENTS IN RECONSTRUCTIVE SURGERY OF THE FACE

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Organized medicine and surgery is confronted now with its particular responsibilities in another great war. It will make the most constructive contribution to this vast destructive cataclysm.

The government has a solemn responsibility to the soldier. It is morally obligated to return him to civil life, if he returns at all, in a condition as good as or better than when he was called from his peacetime environment. He must be returned, if possible, in a condition which will permit him to take his place in society without prejudice and to compete without handicap in the most strenuous economic struggle of all history.

The National Research Council, at the request of the surgeon generals of the Army and Navy, has compiled directives for the guidance of the military and naval surgeon which contain the best in the literature and practice.

This in some respects is an advance over previous preparation. It is particularly true of the preparation for reconstructive surgery. Those responsible for training and medical intelligence in the several armies engaged in the last war failed to collect, review and correlate the isolated but rather complete literature.

This resulted in a reconception of methods, trial and error and many bad repairs before standards were established. Much good resulted from this necessity — this experience — but none of the errors should be repeated.

The plastic surgical experience of the last war was a great contribution and a stimulus to better reconstruction. It crystallized and standardized numerous procedures. It contributed several important new methods which revolutionized plastic procedure and increased greatly the possibility and variety of useful repair. Among these was

the "tubing" of the pedicle of a flap to reduce the possibilities of infection and to permit the safe transference of tissue from a distance.

The influence of the tubed pedicle on the development of reconstructive surgery during the past twenty years has been profound. This, and the availability of rotated flaps of forehead skin for repair of the nose, eyelid or cheek and the use of free skin grafts has largely dominated the conception and practice of facial reconstruction.

This has been true particularly since the popularization of "thick, split skin grafts" by Blair and the more recent contribution by Padgett of a mechanical means of obtaining them.

The results are more functional than cosmetic, except in certain rhinoplasties. These are "procedures of necessity" rather than the "procedures of choice," which their universal use today would seem to indicate.

This general trend of thought and procedure is unilateral thought in respect to the dual responsibility of the surgeon — i. e. to restore to normal, or as near to normal as possible, both function and appearance.

The thinking must become bilateral if the surgeon is to discharge his obligation to the civilian and the soldier. The objective must include restoration of both function and appearance. The latter precludes any plan of repair which adds a single unnecessary scar or foreign tissue to any visible portion of the body. The pendulum should swing for the present to the other side of the surgeons' responsibility. The art and finesse of reconstructive surgery should receive more consideration. His major thought in planning and execution should be directed toward a better, more acceptable final appearance. He should realize that the end results of pedicled flaps, rotated forehead flaps and free skin grafts are such that they should never be considered procedures of choice for facial repair even though they must be employed frequently as procedures of immediate necessity. When such is the only procedure available, the planning should contemplate the ultimate replacement of the trans-

planted skin, with normal skin from the vicinity whenever possible. I have never seen a transplanted skin flap that matched and blended with its surroundings. It becomes the most noticeable and prominent feature of the face even under the best of circumstances. It is frequently pigmented or has a glazed, grayish white cast and is necessarily framed in a scar of varying dimension. Utilization of the skin of the forehead results in a disability which can never be corrected.

Two important and essential principles of repair were ignored or given scant attention during the last war and have received little more consideration since, except in isolated quarters. I refer to the Z plastic procedure and multiple excision. The former was first described by Denonvilliers[1] in 1856 and the latter by Morestin[2] in 1915. Z plastic has been discussed in the literature occasionally since as a method of correcting scar contractures. It has had wide employment in this connection, but numerous other possibilities of its usefulness, both alone and in combination with other principles, appear to be unappreciated.

Davis and Kitlowski,[3] in an article published in 1939 dealing with the usefulness of Z plastics for the correction of scar contractures, state "We find that there are many who do not understand the procedure at all, or realize its usefulness."

"Multiple excision" is the term utilized by Morestin to describe a method of correcting a surface deformity by repeated partial removal and the replacement of the excised portion with normal tissue from the border of the defect. The extent of each removal and replacement is determined by the amount of skin and subcutaneous tissue which can be shifted into the area at each procedure. Repeated procedures of this sort at proper intervals are possible because the skin subsequently returns to its normal tension and elasticity. It is a most important and useful procedure alone or employed in conjunction with other methods of repair.

The employment of the principles of Z plastic, multiple excision and interpolated flaps from the vicinity of the defect should have first consideration in the planning of a correction whenever the

surgeon can choose his procedure. The methods in common practice today, as evidenced in the current literature and observations in various centers, should be procedures of necessity only. They should be employed with the intention of removing ultimately the transplanted skin covering whenever possible.

I am able to contrast typical examples of the current conception of repair, as recorded in recent journals and observed among the patients of my contemporaries, with the results obtained by utilization of Z plastics, multiple excisions and interpolated flaps from the neighborhood and combinations of these methods through the permission of authors, publishers and colleagues to use their material. The cases here cited are examples of the excellent technical accomplishments of master surgeons. They represent the types of repair that fill the files of every good plastic surgeon.

Repair of the Nose

The loss pictured in figure 1 includes the nasal tip, small mesial portions of each ala and the columella. The tissue requirement for reconstruction is an epithelial lining and hairless covering skin which will blend with the nose in color and texture. The skin should be of such consistency or carry with it sufficient subcutaneous fat to restore contour.

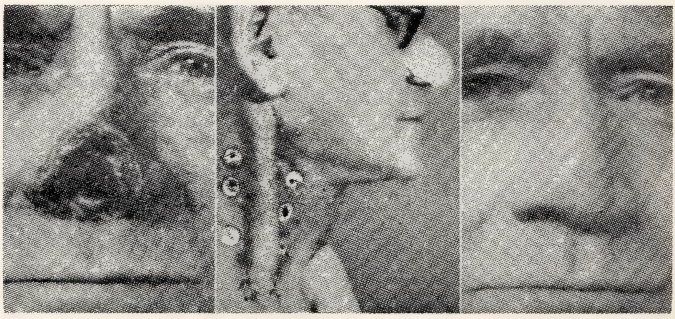

FIG. 1. Unhealed traumatic loss of the nasal columella, tip and mesial portions of both alae (left). Tubed pedicle, formed from a rectangular flap removed from the neck, for transference of hairless retrá-aural skin to the nasal defect. Relaxation sutures and buttons (middle). Final results (right): Note the extent of the repair, which is practically identical with the healed lesion in figure 2. (Courtesy of Dr. Claire Straith, *Am. J. Surg.*, 43:226 [Feb.] 1939).

This tissue may be obtained from a distance and transferred on a tubed pedicle either directly or on a "carrier," or it may be obtained locally (nose) and supplemented by a free graft of skin which will match as closely as the transferred flap.

The surgeon in this instance chose the hairless skin over the mastoid area. He constructed a tubed pedicle to carry this skin to the nose and maintain its nourishment until it acquired an adequate blood supply from the borders of the defect. The denuded area behind the ear was grafted with skin which will not blend with its surroundings. The tube was scrapped after serving its purpose. The technical accomplishment of these procedures is excellent and the result obtained is apparently very satisfactory. It is an example of a universal method — a type of planning.

There is an unnecessary long suture line and relaxation stitch scars in visible portions of the neck and a graft behind the ear. Two cosmetic disabilities have been created in correcting a third.

The case pictured in figure 2 presents a similar loss with the same requirement. The planning in this instance was based on a desire to avoid any cosmetic disabilities distant from the local loss and to obtain, at the same time, a pleasing reconstruction. This was accomplished by a combination of a grafted, rotated flap from the border of the defect, a free graft on the denuded nasal dorsum and subsequent removal of this graft by multiple excision. No added scars were created about the face and neck.

The tip of the nose may be restored in a similar manner. Sufficient skin from the dorsum is rolled downward to provide contour and substance and the defect of the dorsum corrected with a free skin graft taken from behind the ear. The skin defect on the ear is approximated and leaves an invisible scar. The graft on the nasal dorsum may blend with its surroundings satisfactorily, and, if it does not, it is removed by multiple excision.

The restoration of the columella alone should not be accomplished by rotating flaps from the lip or surrounding cheeks. Two methods, other than the one demonstrated in figure 2, which do not result in added visible deformities are available.

One of these methods provides the required tissue by grafting a flap on the posterior surface of the upper lip and transferring it to the nasal tip as a tube, and the other by constructing a pencil tube along the upper surface of the clavicle and transplanting a portion of this. The scar running across the base of the neck renders this method unsuitable for a female casualty.

The ala may be reconstructed also without added scars about the face and neck. This may be accomplished by utilizing a delayed, reflected, hinged flap from the lateral surface of the nose above the loss to provide a lining and the rolled margin of the nostril. The total resulting surface defect is covered with a full thickness graft from behind the ear. This transplant does not match the surrounding

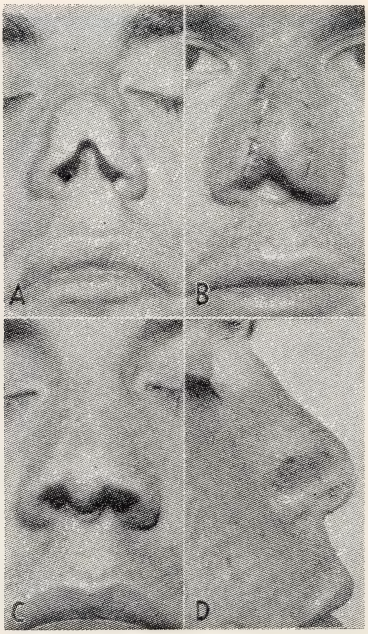

FIG. 2. Healed traumatic loss of the nasal columella, tip and mesial portions of both alae (*A*). Incised, grafted and delayed flap to furnish lining and surface skin for the repair (*B*). Final appearance after removal of grafted skin by multiple excision (*C and D*). Compare figure 1. (Manual of Standard Practice of Plastic and Maxillofacial Surgery, Philadelphia, W. B. Saunders Company, 1942.)

nasal skin perfectly but rather approximately. It is as good as skin from the forehead. Its use avoids added visible scar and confines the cosmetic disability, such as exists, to the locality of the loss.

A method described by Kazanjian[4] produces in many instances an even better cosmetic result. He outlines the ala by an incision through the skin at a proper level above the margin of the defect, separates the lining from the nasal process, divides it high in the nose and draws the alar margin down to the proper level. The resulting defect in the surface skin is covered with a full thickness graft from the back of the ear.

Repair of the Face

It is particularly desirable that lesions of the cheeks be repaired with normal skin from the borders whenever possible. The surgeon should adopt, invariably, a plan to accomplish this whenever he is

FIG. 3. Atrophy of the skin. Ectropion from infraorbital scar contraction (radiated nevus) (left). Final appearance after repair with an inframammary tubed pedicle transferred on the hand as a "carrier." Note the excellent patch. Color contrasts are not visible (right). Compare figures 8 and 10. (Wilmoth, C. I.: The Tubed Pedicle Graft in Facial Reconstruction, *Am. J. Surg.*, 53:300, Aug., 1941.)

permitted to choose the procedure. No transplanted skin, either full thickness or a split portion, blends with its surroundings sufficiently to prevent the repaired area from becoming a definite cosmetic disability — the most noticeable feature of the face. This is true not only of the ideal examples of such results but distressingly so in many ordinary instances. It is possible for the female patient to mask such defects with various types of "makeup," but this is hardly desirable for a man in any capacity.

I am fortunate in having the permission of my colleagues, who are master surgeons, to use their contemporary material to illustrate this contention.

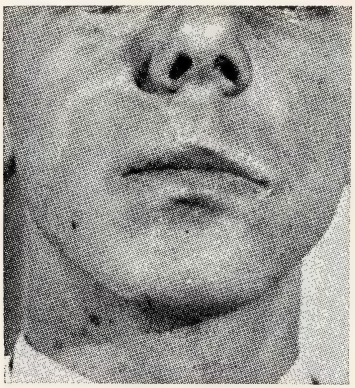

FIG. 4. Flap transferred on a tubed pedicle from the upper arm for reconstruction of the mouth and cheek. Fourth degree burn in infancy. Appearance eighteen years after repair. The patch is the most arresting feature of the face.

The case illustrated in figure 3 is an atrophic deformity with ectropion of a lid resulting from the pull of contracted scar. The surgeon had a choice of procedure. He elected to excise the deformity and repair the defect with a tubed inframammary flap transferred on the hand as a carrier. The technical accomplishment is excellent. The cosmetic result is a patch representing this cheek area. It will always remain the most noticeable feature of the face, despite the fact that it is a perfect surgical repair. (Compare figures 8 and 10.)

Figure 4 pictures an old repair (1924) of a microstoma resulting

from contraction of the scar from a fourth degree burn. The skin flap was transferred on a tubed pedicle from the arm. It is one of the best in my personal experience. Its individual color is excellent. The vasomotor control is sufficient to permit the patient to blush in this patch. It approximates but does not blend with the surrounding skin. It is the most noticeable feature of the face. It has served its purpose long since and should be removed by multiple excision to bring normal skin into this area.

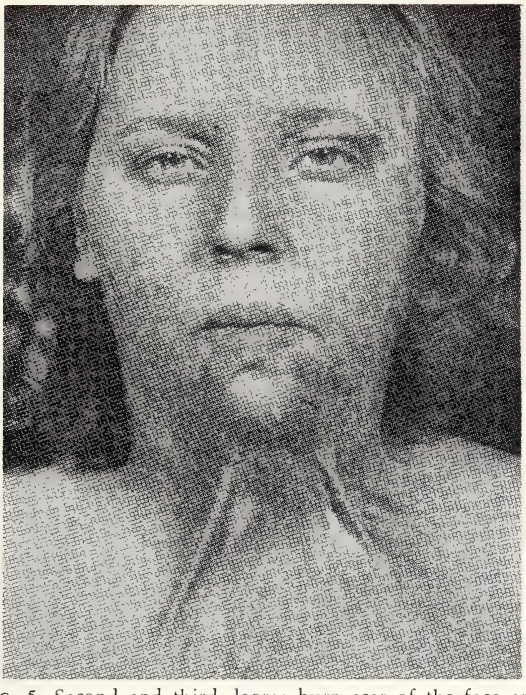

FIG. 5. Second and third degree burn scar of the face and neck; scar contracture. See figure 6.

Figures 5 and 6 feature a case in which the introduction of new skin from a distance was a "procedure of necessity." The surgeon had no opportunity to utilize bordering skin in this repair. He has planned and accomplished skilfully one of the best cosmestic results from this procedure that I have seen. The contrast of these perfect flaps with the surrounding normal skin serves to emphasize my purpose in this discussion.

Figure 7 depicts partially the result of a free full thickness graft (see figure 9 also). It is impossible to show the color contrast that evidently exists.

The operator, Dr. Padgett, states that this graft has "some brown pigmentation" but that the patient "on the average looked pretty good. I agree that a skin graft does not compare with the surrounding tissue. Sometimes there is some pigmentation but, ordinarily, ours are a little whiter in color than the normal skin." This patch, excellent as it is, is the most noticeable feature of the face.

The large pigmented hairy nevus pictured in figure 8 was removed and the area repaired by a combination of methods. The portion occupying the left temporal region was replaced by a full thickness graft from the abdomen, which the operator, Dr. Warren Davis,

FIG. 6. Final appearance of patient shown in figure 5 after the employment of double tubed pedicle abdominal flaps transferred on the hand and arm as a "carrier" (right). An excellent repair employing the "procedure of necessity." (Figures 5 and 6, courtesy of Dr. Gustave Aufricht.)

states "retains a lighter shade than the remainder of the normal skin." Several excisions within the nevus on the cheek and replacement of the remainder with a split skin graft (0.017 inch) from the back completed the repair.

FIG. 7. A woman aged 27 after replacement of a hemangioma of the cheek, lower eyelid and upper lip. The lesion on the cheek and upper lip was replaced at the age of 18 with a full thickness skin graft. A thick Thiersch graft was employed for the lid. The color contrasts do not appear adequately. Compare figures 9 and 11. (Padgett, E. C.: *The Journal,* Jan. 2, 1932, p. 18.)

The use of grafted skin on the temporal region was a "procedure of necessity' while the employment of a graft on the cheek was not. A continuation of the "multiple excisions" combined with a Z plastic to change the line of traction on the lower lid would suffice to replace the nevus with normal bordering skin.

This result affords the opportunity of comparing the cosmetic value of full thickness and split portions of skin on the same patient. The procedure, despite its skilful execution, replaces a decided cos-

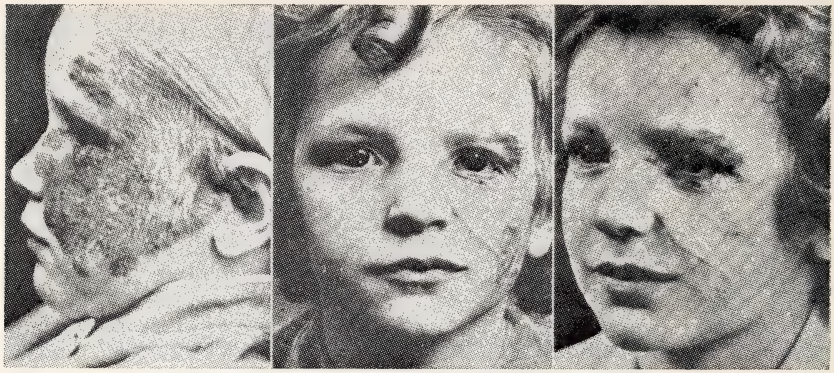

FIG. 8. Pigmented hair nevus (left). The lesion in the temporal region is replaced by a full thickness skin graft. The lesion on the cheek was partially removed by multiple excision and finally replaced with a split skin graft. Color contrasts do not appear. The graft remains the most arresting feature of the face (middle and right). Compare figures 9 and 10. (Courtesy of Dr. Warren Davis.)

metic blemish with another of less degree which remains a definite disability (compare figures 9 and 11).

The patient featured in figure 9 presents atrophic patches of the skin of the cheek and an infraorbital sarcoma as the result of repeated roentgen irradiation of a pigmented vascular nevus. The surgeon had a "choice of procedure" in this instance. A procedure consisting of multiple excision and the use of Z plastics to deter-

FIG. 9. A pigmented vascular nevus presenting patches of skin atrophy and an infraorbital sarcoma as the result of roentgen irradiation and treatment with radium (left). Appearance after excision of the sarcoma, three excisions of the pigmented lesion and a Z plastic to introduce normal skin infraorbitally without producing an ectropion (middle). Appearance three months after completion of repair (right). Compare figures 3, 7 and 8.

mine lines of traction was elected. The cosmetic disability consists of a fine line scar in front of the ear and line scars in the nasolabial groove and infraorbital region. The face is covered with normal skin.

FIG. 10. Scar from a third degree burn; destruction of the nasal skin covering and the left ala; hypertrophied scar and keloid (left). The nose has been covered with whole thickness skin from the mesial surfaces of the ears. A Z plastic has placed normal skin in position for multiple excisions of the hypertrophied scar on the cheek (middle). Appearance as the reconstruction nears completion. The Z plastic for removal of the scar on the lip is incomplete (right).

The patient pictured in figure 10 presents a third degree burn scar covering the entire nose and areas of hypertrophied scar and keloid in the cheek. The nose has been recovered with full thickness skin taken from the back of both ears. The gross scar and keloid on the cheek and about the mouth has been removed by a Z plastic to introduce normal skin from the neck into the cheek and subsequent multiple excisions.

The patient seen in figure 11 presents a loss of the major portion of the left half of the upper lip, decided atrophy and pigmentation of the soft tissues of the infraorbital area of the face and lateral half of the nose and ectropion of the left lower lid. This resulted from early treatment of a nevus with radium and roentgen rays.

The surgeon had a "choice of procedure" in repairing each of the several defects. The lip has been restored by utilizing rotated flaps of the skin and subcutaneous tissue from the border of the defect without any damage to the muscles of expression. This procedure is sufficient to construct good lips with normal skin covering in all cases in which the bordering tissue is not destroyed or is so

badly damaged by scar as to be useless (compare figures 12 and 13). The atrophied, pigmented skin of the face was replaced by normal skin as the result of multiple excisions and Z plastics. The eyelid was repaired by releasing the margin of the lid, creating adhesions between the two lids and grafting the resulting defect with skin removed from the uper lid (compare figures 3, 7 and 9).

The patient shown in figures 12 and 13 presents a loss of the mental segment of the mandible, the floor of the mouth, a portion

FIG. 11. Ectropion, cataract, atrophy of the skin and underlying tissues, arrested bone development and partial destruction of the lip as the result of roentgen irradiation of a pigmented nevus in early childhood (*A*). Reconstruction of the ectropic eyelid with a full thickness graft from the upper lid. Surgical adhesions of the lids to prevent contraction during the period of organization and outline of the flaps for reconstruction of the lip and face (*B*). Completed construction of the lip, surgical adhesion of the lid margins and advancement of normal skin into the atrophic area (*C*), Appearance two months after completion of the repair (D). Compare figures 3, 7, 8 and 12.

of the left upper lip, the left half of the lower lip and a small portion of the adjacent cheek as the result of a gunshot.

The plan of repair admits "choice of procedure." The surgeon chose to bring in tissue from a distance on a tubed pedicle. He has not only introduced skin into the face which will not match its surroundings but has created a large scar on the neck and chest. The defect could have been repaired with normal skin from its margins and the scars confined to its borders. This is an excellent example of the generally accepted type of planning and procedure (compare figure 11).

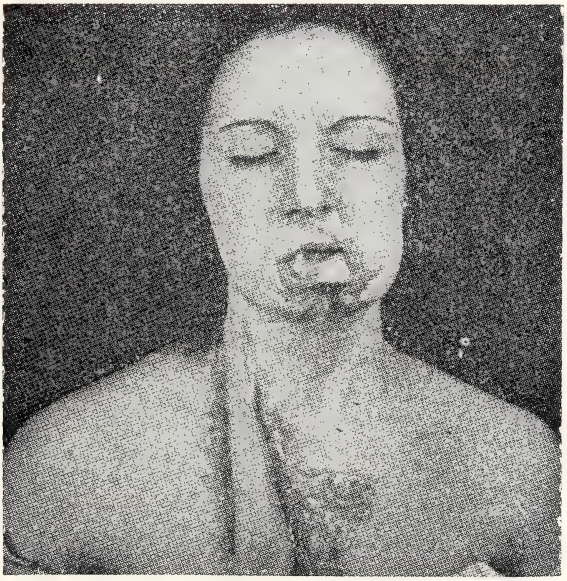

FIG. 12. Gunshot wound. Loss of the mental segment of the mandible, the floor of the mouth, a portion of the left upper lip, the left half of the lower lip and a small portion of the adjacent cheek. Prosthetic piece in the mandible; a skin pedicle tubed on the neck and chest; large scar on the neck and chest.

Summary

1. The evolution of and the universal modern practice in facial repair has been profoundly influenced by the popularization of tubed pedicle flaps, free grafts and rotated flaps from the forehead.

2. Reconstructions utilizing these methods are procedures of necessity and not procedures of choice.

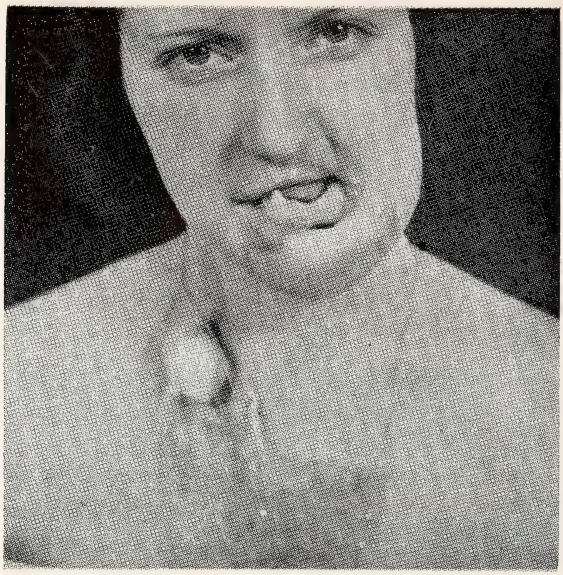

FIG. 13. The floor of the mouth of the patient shown in figure 12 was repaired with the skin pedicle. Stump of the tubed pedicle and a large scar on the neck and chest (right). Compare figure 11. (Figures 12 and 13 courtesy of Drs. John Kemper and Reed Dingman.)

3. The cosmetic result of such repairs merits more consideration.

4. A better understanding of the varied uses of Z plastics, the employment of the principle of multiple excision and the use of flaps of normal tissue from the vicinity of the deformity will improve greatly the end results.

5. The plastic surgeon in this war has a solemn obligation to the soldier as well as to the casualty victim in civil life which can be discharged only by careful consideration of the art and finesse of the practice.

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RELATION OF THE EARLY CARE TO THE FINAL OUTCOME OF MAJOR FACE WOUNDS IN WAR SURGERY

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Personal observation of wounds of the above type made in the advanced, intermediate, and back areas in the A.E.F. during the active periods in World War I, subsequent opportunity to follow part or all of the later treatment in the majority of those returned home as casualties, and a somewhat cursory review of the final report of the Surgeon General, seem to warrant the following vitally important conclusions.

(1) That proper early care can be life-saving; (2) it conserves tissue that cannot be duplicated; (3) it better fits the casualty for early evacuation; (4) it can reduce, possibly by months or years, the treatment-time so often necessitated by a bad start; (5) it will also, on the average, require simpler secondary procedures, and (6) be followed by better final results.

Early treatment can be summarized under four procedures, enumerated in the order of their importance, the first two being life-saving and the second two influence treatment-time and the quality of result.

1. Establishment of a free airway, control of bleeding and shock.
2. Make no tight closure of wounds within the floor of the mouth or the lower bucco-labial sulci without ample provision for inferior drainage.
3. All displaced fragments or masses of the face bones should be restored to and fixed in proper position as early as is practical; if not immediately, preferably within the first two or three weeks.
4. Do not remove from the face any still attached bone or possibly viable soft tissue.

Amplifying, for clarity, the above general statements, we would

roughly define as "face wounds" all those, superficial or deep, the major part of which involve tissues bounded above by the hair-line and below by the plane of the hyoid bone, but excluding the cranial cavity. From the final report of the Surgeon General of the Army, one gathers that more than 3,000 out of somewhat more than 8,000 wounds of the face among the A.E.F., proved fatal. As far as we know, this is a far higher mortality rate than for serious face injuries due to traffic or industrial accidents. There are two factors in the former group that might largely account for this discrepancy. (1) A bullet or shell fragment can cut a deep vessel, causing hemorrhage difficult of access in field conditions, or might do damage that obstructs breathing, and this is a common type of wound in war, while rare in civil practice. (2) The victim of a serious street or industrial injury is usually hospitalized within minutes or a few hours, while many hours, or even days elapse before some battle casualties are given hospital care.

Treatment.—1. The most demanding indication is establishment of a free airway, but, directly or indirectly, hemorrhage is likely the common cause of death in these face injuries. At the field hospital or even a dressing station, efficient packing might be done, even of the pharynx after a stab tracheotomy, or in some instances the bleeding vessel can be caught or even the common carotid might be ligated; under thirty years of age the latter is not apt to cause permanent brain damage. In the above cases, death might come from exsanguination, asphyxiation, or shock, therefore one so wounded should be placed semiprone to give a free airway during transportation and while making attempts to control bleeding. An old, somewhat heroic procedure for uncontrollable bleeding is to hold the man erect until he faints and then quiet him with a small dose of morphine. The latter might not be practical for massive hemorrhage, but if done early for a cut artery the size of the radial or less, the blessé might lose less blood than if left lying flat from the first. An early transfusion can again start bleeding from an unligated but clot-controlled vessel wound.

2. The prohibition against closing wounds in the floor of the

mouth stands as stated. This might initiate a spreading induration, possibly fatal under conditions of transport. The principle is time-tested and should not be scrapped.

3. Next to life preservation, the most demanding indication in the care of the recently injured regards continuity of the bony framework.

Fractures in the mandible do not impact and displacement here, due to muscular pull, will vary with the position, direction and number of fracture planes. Those within the maxillo-malar mass or "upper jaw" are usually impacted, but a transverse fracture at the base of the skull will remain mobile and later the face will sag downward, while fractures of the orbital borders and nasal bones are impacted as a rule.

Most fractures of the body or ramus of the mandible, either single or multiple, require only fixation in occlusion by the Gilmer plan of wiring the lower to the upper teeth. Those of the body are usually contaminated by mouth secretion, and an early stab drainage opening made from under the border into each fracture plane will largely prevent the induration and loss of partially detached bone fragments due to pocketed mouth secretion, and the repair time will be materially shortened. Displacement of an anterior segment that lacks teeth suitable for anchorage can be controlled by a wire loop passed around the segment, closely hugging the bone, with the free ends fixed either to a tooth or wire arch above; or by releasing muscle-pull with an open-bite (Gunning) splint. Occasionally, we have, in neglected cases, drawn forward a retracted mental fragment by weight and pully traction, or anchored a displaced edentulous posterior fragment by direct bone fixation, the latter done with chromic catgut or tendon, as here buried wiring can cause late complications. Later, usually three weeks or so, partial union of the body fragments can be supported by a Gilmer posterior band splint provided there is one solid tooth for fixation distal to the fracture. Alveolar displacements should be pushed into position. Separation of the coronoid process or the condyle of the mandible is ordinarily best treated conservatively

without regard to the local displacement by fixing the jaws in occlusion for three weeks. A blow on the chin can without fracturing the mandible cause collapse of the bony auditory canal or fracture of the odontoid process of the axis.

With fractures of the maxillae through or above the palate, the displacement may be backward, up-tilted or lateral; in any case, early wiring the teeth into occlusion after releasing the impaction and insuring patulence of the nasal airway is likely all that is required, but late correction has in our hands proved quite a formidable procedure. A mass sagging of the face after fracture through the orbits is also treated by the same dental fixation even though both jaws be broken, but for an interval the maxilla might advantageously be supported by the Gilmer plan of reversing the Kingsley splint, with the bandage encircling the vertex. This latter is especially applicable for cases with nasal obstruction or those seen late but with no fixation. However, this inaccurate up-pull should be discarded and the two arches wired in occlusion before bony fixation takes place; otherwise a permanently uptilted dental arch is likely to result. The co-operating dental surgeon will be found familiar with the types of splints mentioned and with tooth wiring.

Fracture of the "antrum" usually designates an outward and downward twist of the malar bone, with lowering of the outer half of the orbital border and an outward bowing of the zygoma, an impacted fracture of the antral wall, and often a bursting fracture of the orbital floor. If uncorrected, a downward and backward displacement of the globe and a flattening of the cheek later becomes unpleasantly evident, but the immediate double vision usually disappears spontaneously.

If examined before hard swelling obscures bony landmarks, all of these changes can be recognized by the patiently exploring finger that follows all bony surfaces and borders, external and intraoral, comparing both sides. These findings should also be checked by visual comparisons made from all directions. If the displacement is bilateral the findings might be difficult to interpret, and then a sharp, properly posed x-ray film would be more enlightening.

Much hard, quickly developing swelling with subsidence in 24 or 48 hours is likely due to interstitial hemorrhage, but induration persisting longer might indicate a spreading infection from an apical abscess or sinus. In the latter instance it would be safer to postpone forceful bone replacement until swelling subsides. In two instances after very early maxillary replacement done by the writer, necrosis in the osteoplastic flap occurred. Now the prophylactic local use of one of the sulfanilamide group might be a measure of safety, but not stripping the mucoperiosteum from the bone flap might be an even more potent prophylaxis.

Both for correction and to permit exploration of the orbital floor, we have found the most effective approach is through the canine fossa just above the tooth roots and with chisel or elevator the antral wall is pried outward and upward as a mucous-covered and mucous-lined bone flap. From within, the finger checks on the floor of the orbit, and if down, the fragments are pushed up; with a stout elevator or urethral sound the impacted zygomatic bone is pried free, and if the zygomatic process is intact, the replaced bone tends to stay in position. The floor of the orbit is held up and the restored zygomatic contour preserved by an intra-antral pack. This is made up of a folded strip of one-inch iodoform gauze, slightly impregnated with balsam of Peru, and placed in orderly folds for ease of withdrawal, and also a small irrigation tube, both anchored to a tooth. The outwardly displaced flap of antral wall is pushed mesially and the mucosa incision is partially closed with a few tacking sutures, but with the tube and the pack-end protruding. The tube and packing are left undisturbed for three weeks and on removal the bone flap is pushed completely into place. An elevator inserted at the hairline and passing under both temporal fascia and zygomatic process is an efficient plan for correcting a mesial displacement of this process which later could impede forward movement of the coronoid process, thus limiting mouth-opening.

Impacted nasal fractures can usually be freed within the first three weeks by the prying elevator which will permit the broken or bent septum to resume natural position, but the replaced bones

might need fixation. One or possibly two of the three following plans will accomplish the latter. (1) For a depressed dorsum with lateral spreading of the nasal bones, the bridge is pried free and a heavy curved "surgical" needle carrying a wire or strong silk suture transfixes the base of the nose through the fracture lines, above and below, the needle entering and emerging from the skin slightly lateral of the fracture lines in such a way as to salvage some of the laterally displaced proper nasal covering. The bones are held in normal relation by tightening the mattress suture over a narrow lead plate at each side of the nose. (2) For lateral mass displacement, use the wire-carrying needle inserted so as to engage either the anterior nasal spine, the lower corner of the opposite nasal bone or the dorsal border of the cartilage to form a subcutaneous loop, both ends of which traverse the vestibule and the cheek tissue, to emerge above and anterior to an anchoring upper molar tooth to which the guy-wire is attached after drawing the nose into a somewhat over-corrected position. (3) After certain complicated or comminuted fracture reductions, the bridge of the nose can best be held in position by an intranasal armature that below is attached by a universal joint to a vulcanite base plate cemented to the incisor teeth; any up-tilting of the tip can if necessary be drawn down by a second guy wire that transfixes the septum near the dorsum. This splint is particularly useful where the freed nasal bones had been driven in deeply between the maxillary processes or where there is much comminution of bones and septum. Deep backward displacement of the bridge might easily be complicated by an unrecognizable fracture of the cribriform plate of the ethmoid, and a week or ten days might be profitably expended on prophylactic measures directed towards protecting the cranial contents. This same delay applies also to the replacement of a pushed-in fragment of the outer wall of a frontal sinus and to displacements of the upper orbital border, but those of the outer border of the orbit can be replaced immediately.

(4) The classic "debridement" has no place in face injuries, but after the removal of shreds fresh clean wounds may, possibly as

a first-aid procedure, be drawn together, preferably with catgut that engages the subcutaneous tissues and will not risk added suture scars that might permanently mar an otherwise very good secondary correction. Wherever tissue condition permits, the lips, nostrils, nasal alae and columella, ears, eyelids, trap-door flaps of skin, and displacements of the nasal cartilages or mucosa should be immediately tacked in place as should also mass displacements of face tissues. A soldier with wide cheek tears or loss might be rendered transportable earlier and with greater comfort by following the British practice of tacking the mucosa to the skin across the raw surface.

In the A.E.F. in World War I early care of face injuries was somewhat standardized and its importance emphasized by a small group of teams: surgeon and dentist, previously somewhat familiar with this work, being assigned as regional consultants, while the Senior Consultant was authorized to make inspection tours from front dressing stations to debarkation ports. All of this helped to promote a co-ordinated sequential plan of treatment which can be considered as largely responsible for the somewhat curious fact that the majority of face injuries evacuated to the United States for treatment had occurred before the battle of St. Mihiel, while from the later engagements, Argonne, etc., apparently rather few were sent home as casualties.

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THE CORRECTION OF SCARS

By HANS MAY, M.D., F.A.C.S.
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Scars usually follow the destruction of tissue resulting from trauma, burns, operation or disease. Their appearance or their painfulness may annoy the patient or they may cause limitation of function. If an operative correction of such scars is undertaken, several general rules must be observed. The tissue which formed the scar must have reached a state of quiescence, recognizable by the pale color and softness of the scar. With a simple scar the stage may be reached by the end of the fourth week. Scars due to burns, however, may not be operable before the end of a year. Massage and *x*-ray treatment often help to shorten this time.

In discussing the plastic repair of scars it is important to distinguish between simple and extensive scars. Both types can be smooth, hypertrophic, depressed or contracted.

THE CORRECTION OF SIMPLE SCARS. — The *simple scar,* whether smooth or hypertrophic, is not always easy to correct. The incision outlines the scar and penetrates at either side of the scar into the

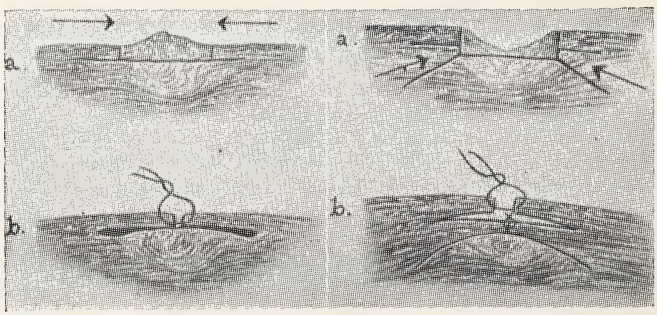
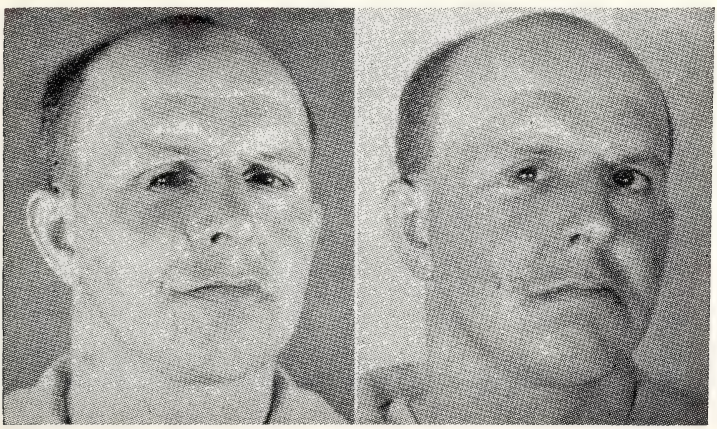


FIG. 1. *a,* correction of simple hypertrophic scar; excision of scar, leaving basis of scar intact upon which the wound edges are approximated, *b,* correction of simple depressed scar; excision of scar leaving basis of retracted area intact. From the corners of the defect a bilateral incision is carried obliquely downward and outward. The mobilized skin and subcutaneous tissue is approximated upon the scar buttress.

subcutaneous tissue, but not deeper. The subcutaneous tissue is kept intact to act as a basis upon which the wound edges should be approximated. (Fig. 1A) With a pair of fine, sharp, curved scissors the scar is excised. The wound edges are mobilized and separated from the subcutaneous tissue in a circumference of about 1 cm. Exact hemostasis is the next step. If possible, ligatures should be avoided and the bleeding controlled by pressure. If ligatures are unavoidable they should be made with the finest silk. The suture of the wound edges should be carried out with horsehair and consist of on-end mattress sutures supplemented with simple interrupted sutures. The wound edges are not grasped with a forceps but only elevated by one prong to facilitate the penetration of the needle. If the wound edges are not under tension and are straight, Halsted's subcuticular wire suture is of value. I prefer to cover the wound with silver foil which keeps it dry and aseptic. The simple sutures are removed on the second or third day; the remaining sutures on the fifth day after operation.

If the simple scar is *depressed,* the technique for correction differs. The incision outlines the scar and penetrates at either side to the base of the retracted area, but not further. The scar is now excised

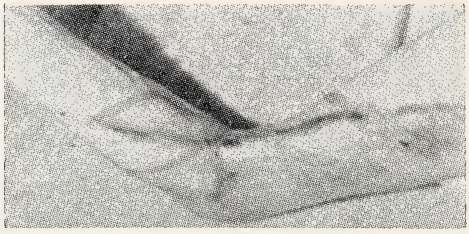


A B

FIG. 2. A, correction of depressed scar in right nasolabial fold and of contracted scar of lateral part of eyelid. B, scar in nasolabial fold corrected according to technic as represented in Figure 1*b*; scar of right eyelid corrected with Z method.

as previously described. From the deep corners of the defect a bilateral incision is carried obliquely downward and outward, leaving the base of the scar intact to act as a buttress. (Fig. 1B.) The adjoining tissue thus mobilized is approximated upon this buttress and transfixed by on-end mattress sutures supplemented with simple interrupted sutures. (Fig. 2.) In some instances it is better to suture subcutaneous tissue and skin in layers after mobilization of the skin edges from the subcutaneous tissue.

If the simple scar is *contracted,* the entire scar tissue, including the base, must be excised until the whole defect thus created consists of normal tissue. One ordinarily succeeds now in releasing the contracture unless the latter has been of long standing. Usually some sort of tissue shifting is necessary to close the defect. In cases where the contracture is due to a binding web the Z type of relaxation incision with exchanging flaps is the operation of choice (Davis[1,2]). The object of this operation is to interrupt and displace the binding web by the formation and transposition of two triangular flaps



A

B

C

FIG. 3. A, correction of simple contracted scar by the Z type of operation. The central lines of the two Z's are laid along the web. The arms of the Z's are marked out on opposite sides of the central lines. The two triangular flaps of each Z are transposed. B, same patient six months after operation. C, same patient one year after operation.

which are placed so that their outlines form a Z. The central line of the Z is laid along the most prominent portion of the web and the arms of the Z are marked out on opposite sides of the central line. The two triangular flaps thus outlined are mobilized. The contracture is now reduced as far as possible and the two flaps are transposed. If the binding web is long, several such Z's may be formed and their flaps transposed as demonstrated in Figure 3.

Correction of Extensive Scars. — Extensive smooth scars are in the same plane as the skin. Ordinarily they do not cause any trouble since they do not contract. However, they tend to become annoying if they are situated in such exposed regions as the face or neck. In these cases repair work may be requested. If the scar is not too extensive and elliptical and the surrounding skin is freely movable, the scar is treated as if it were simple and smooth. It is excised down to the subcutaneous tissue, but not further. The wound edges are mobilized subcutaneously and approximated until a linear suture can be established. If the defect left after excision of the scar

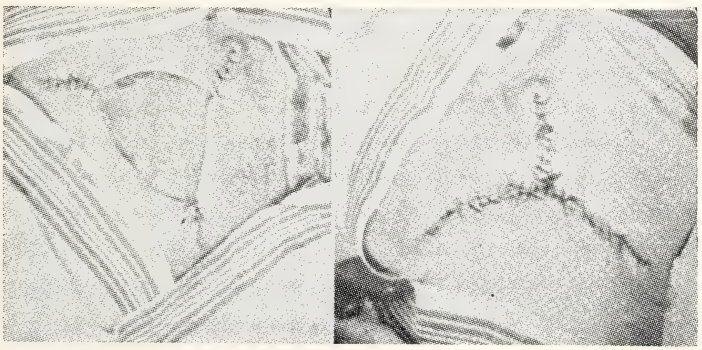
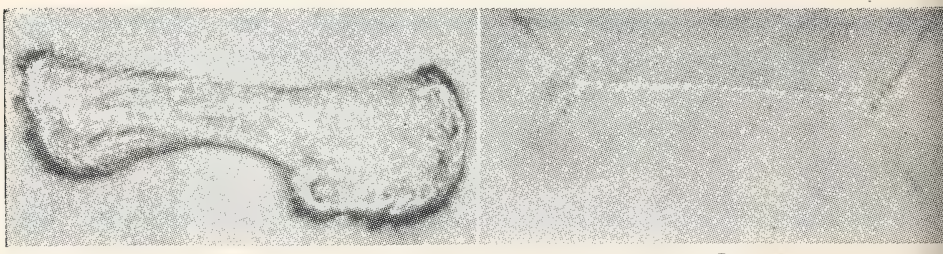


Fig. 4. Triangular defect after excision of flat scar closed by starting with closure of the corners.

is triangular (Fig 4) or rectangular (Fig. 5) and the surrounding skin is freely movable, plastic closure might be achieved by starting with closure of the corners.[3] It is important to avoid undue tension in the sutures by choosing a procedure by which the scar is partially excised and sutured in several stages. During the intervals the skin is allowed to stretch until all parts of the scar are removed. If the

scar is too large to permit closure of the defect by simple tissue mobilization or tissue gliding, covering of the defect by a full thickness skin graft or pedicle flap is advisable. The disadvantage of the graft or flap, however, is the difference of color and a slower healing process.[4]

The *extensive hypertrophic scar* is usually due to keloid formation. We do not know as yet the cause of keloid development and for this reason the treatment is rather vague .It is a well known fact that even after a complete excision of a keloid it may recur after a few weeks no matter whether the defect is sutured primarily, covered by a skin graft, left to granulate, or electrocoagulated. The most efficient treatment at the present time is radiation by *x*-ray or radium, preferably after excision of the scar. If the keloid extends over a large area and this area happens to be in a place where the skin is very movable, one may attempt an excision of the entire area. The skin surrounding the defect is mobilized and approximated until a linear suture can be established. *X-ray* treatment is applied postoperatively. If this scar, in spite of excision and radiation, develops again into a keloid, the second is many times smaller than the first. (Fig. 5.)

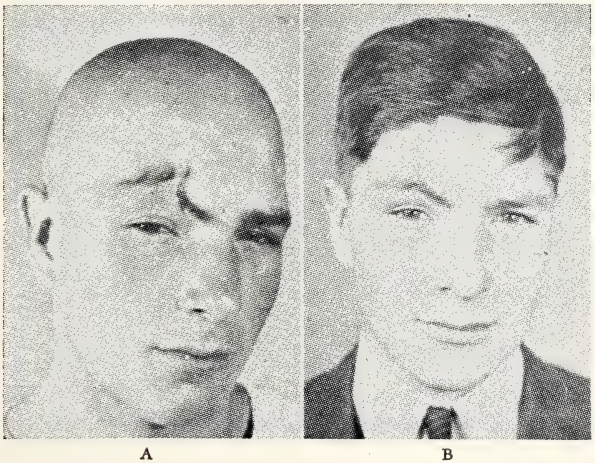


A B

FIG. 5. A, rectangular defect after excision of large keloid scar closed by starting with closure of the corners. B, same patient ten months after operation.

If an extensive scar is retracted or depressed, the technique of correction differs from that used in simple depressed scars. In the majority of cases the involved area is too large to allow an approximation of the neighboring subcutaneous tissue to fill the defect. Hence the repair work is mostly combined with grafting fat, bone

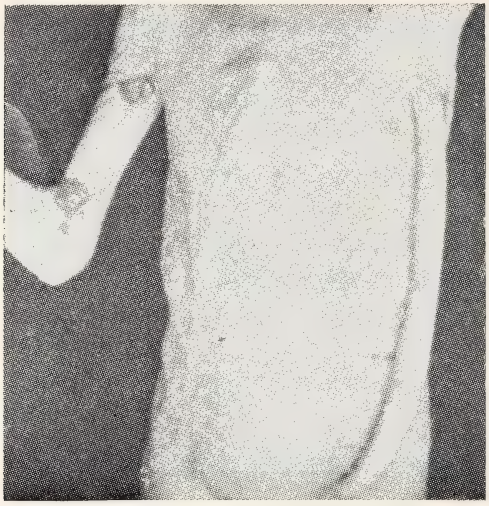
or cartilage in order to restore the normal surface contours. The scar is excised down to its base. The skin surrounding the defect is mobilized; then, after careful hemostasis, a properly shaped piece of bone, cartilage or fat is transplanted into the defect before the skin is closed over it. The choice of the material is not free but is dictated by local conditions. If grafts of fat tissue are used their subsequent shrinkage must be taken into consideration. The shrinkage amounts to about two-thirds of the size of the graft. Cartilage and bone are not apt to shrink. I prefer to take fat tissue grafts from the outer posterior surface of the thigh, cartilaginous tissue from the fused portions of the seventh and eighth ribs, and bone from the anterior surface of the tibia. If simple mobilization of the skin does not suffice to close the defect over the graft, additional incisions must be made to allow more liberal shifting or rotation of skin. In such cases, however, secondary defects may be left and one must be sure that they can be closed. In extreme cases transplantation of skin by pedicled flaps is the last resort. A patient was kicked by a mule on the right side of the forehead when he was 4 years old and acquired a deep depressed scar due to bone and skin defect. His right eyebrow was split and the lateral half displaced



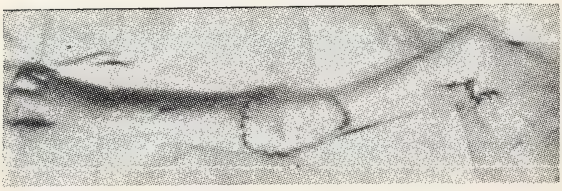
A B

FIG. 6. A, large depressed scar on forehead with displacement of right eyebrow. B, same patient seven months after excision of scar, rotation of right side of scalp and transplantation of fat tissue.

upward. (Fig. 6.) When he was 21, I excised the entire scar, mobilized the surrounding skin and filled the depressed part with fat tissue taken from his left thigh. To rotate the displaced lateral half of the right eyebrow the incision was lengthened upward and backward, thus outlining a large flap consisting of nearly the entire right half of his scalp. The flap was mobilized and was then easily shifted downward, covering the original defect and allowing align-



A

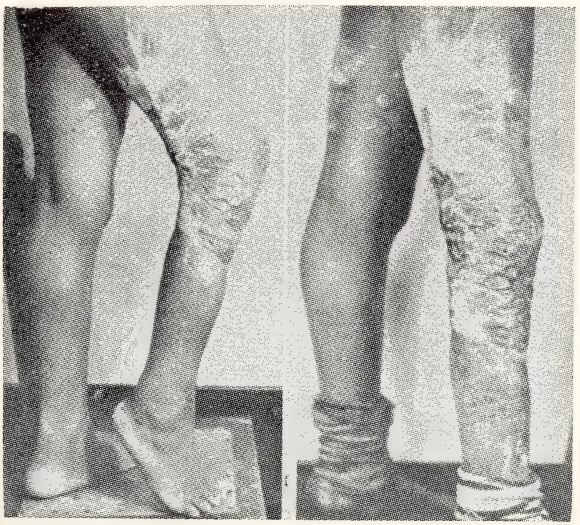


B

FIG. 7. A, eight year old boy with contracted scar of right elbow joint and axilla due to burns. The burned area included the entire right half of chest and abdomen. A tubed flap was formed from left thoracico epigastric region (Webster). B, the tubed flap was transplanted into the defect of the right elbow after contraction had been overcome. Contraction of right axilla was corrected by the Z operation.

ment of the right eyebrow. The secondary defect at the occiput could then be closed.

Correction of *extensive contracted scars* is one of the most difficult problems in plastic surgery. The extensive contracted scar is usually caused by destruction of the deeper parts of the surface tissue, and appears usually at the flexor surface of the extremities or at the junction of limb and trunk. In some cases much can be done to avoid them to a greater or less degree by proper immobilization of the affected limb during the healing stage. Before any operative correction is undertaken one should wait until the scar tissue has reached its final stage, although waiting to long may cause joint ankylosis and shortening of tendons and ligaments. Active and passive motion exercises of the affected limb during the waiting time is advisable. The objects of treatment are to remove the scar, to replace it by normal tissue, and to restore function. The scar must be removed entirely until normal tissue is exposed; only then can contracture be overcome. The defect is covered by a skin graft or pedicled flap, the proper choice of which is dictated by the local conditions and



B A

FIG. 8. A, large contracted scar of right leg. B, same patient eight months after division of binding web of scar, correction of contraction and skingrafting of defects.

the peculiarities of the various kinds of transplants. (Fig. 7.)

If a scar is very large, however, as after extensive burns involving the entire thigh or leg, it is inadvisable to remove the whole scar as it would be impossible to obtain sufficient skin with which to cover the defect. To relieve these large, thick, contracted, adherent scars, Davis[1] advises relaxation incisions. The contracted portion is stretched and the most binding area or areas are located and marked out. The scar is divided completely until normal tissue is reached. Sometimes radiating incisions from the tight margins are necessary to complete relaxation. If, after the relaxation incisions are made, the scar is found to be very thick, Davis advises excision of a wedge-shaped slice of the deeper layer so that the thinned surface edges may be drawn downward and attached to the normal base by a few sutures. The defect is covered primarily or secondarily with skin grafts.

If the cicatricial area is too extensive the procedure should be done in stages. In the case represented in Figure 8 the binding web was so long that two relaxation incisions were necessary. The edges of the defect created after the incisions were unusually thick — 1½ inches. Although slices of the deeper tissue were excised and the surface edges attached to the normal base, yet the defect remained quite deep. The defects were covered with split grafts which, however, partly sloughed away, particularly at the edges. The leg was immobilized in a plaster case for four weeks. After this time granulations had filled out the entire defect, had raised the surviving parts of the grafts from which epithelization spread over the granulating surface with resulting healing. (Fig. 8.) The same relaxation incisions are recommended by Davis for so-called unstable scars where healing is very poor.

Summary

The plastic repair of scars is discussed under two headings: correction of simple scars and correction of extensive scars. Both types can be smooth, hypertrophic, depressed or contracted. Suitable methods of repair are described for each type of scar.

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BURNS AND THEIR TREATMENT

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What to do about burns has always been a problem to command our best attention.

The first consideration is to save the life of the patient, the second is to save him pain.

In recent years the tannic acid treatment of burns has had general acceptance. That method has, however, the secondary effect of leaving scar. Scar is disfiguring. It is contractile and becomes more so the longer it is left.

Contractile scar causes loss of function at the part it covers.

Those in surgery who are called upon to deal with the ravages caused by scar, who have had to remove the scar tissue and replace it with skin under which the tissues can move freely, have long favored the general adoption of a procedure by which this aftermath of burn treatment can be avoided.

In the present war, surgery has set itself the task of preparing burn areas in about three weeks and skin grafting in less than six.

That this is now possible is due in very large part to the efficacy of the sulfa drugs in surface dressings, in combination with internal administration.

My own experience in Spain was the preface to the adoption of the procedures now generally followed in Europe, and which I have recently observed in practice on a grand scale in Britain.

When I was invited to set up an organization for care of war wounded in Spain, and when burn cases came along, as they did in large numbers, I was handicapped by having no supply of the tannic acid and silver then considered essential. I did have at my command an ample supply of magnesium sulphate and also a supply

of sulphanilamide, which I brought with intention to use it in internal administration.

I contributed to one of the medical journals, early in 1940, an account of my experiences in Spain, including what was probably the first report of the use of sulphanilamide as a surface dressing to combat infection in burns and other war wounds.

It may have been a case of necessity being the mother of invention, but the principle seemed to me to be sound, and the results were such that the method I then employed has been adopted and has replaced the tannic acid-silver method completely; although I notice that the tannic acid method still was prescribed by the Medical Service of the United States Army in 1942.

We did succeed, quite remarkably, in mastering infection; control of infection was followed by grafting, and we did avert the disfunction that too often is the sequel of other methods.

For example, by way of contrast, I may mention a case that was presented to me just recently. A young man who was badly burned in one of the great steel works in this country within the year was sent to me for treatment. His hands were gnarled and entirely without function, the only motion of which he was capable being an ineffective approach of the thumbs to the index fingers. This being due to the action of contractile scar, and since it could have been avoided by control of infection and grafting soon after the accident, the condition of this young patient is nothing less than tragic.

The burn problem falls into two divisions; control of the infection that almost invariably follows, and grafting of the burned area.

The skin grafting presents no problem of serious difficulty, apart from the choice of the kind of graft suited to the condition. In this there may be considerable variety of choice, to be determined when the wound is ready.

Combatting infection is by no means as simple a matter. Here I hold that the maximum good is to be sought in a close association

between the operator and the laboratory. To fight infection successfully one must know what kind of invisible life is responsible for it, and on that point the laboratory can supply information otherwise unobtainable.

There is one other point that should be mentioned by way of introduction. The idea that every doctor should undertake the treatment of his own burn cases is on the way out. That has been demonstrated and accepted, where the great number of burn cases incidental to war has compelled a different solution. It will be realized later in respect to burns in civil conditions. In Britain the cases are rushed to centers designated for that purpose.

With this preamble we may proceed with some description of the methods adopted in the handling of burns.

At the earliest possible opportunity the wound is dusted with sulphanilamide and the part immobilized. Treatment for shock includes relief of pain by morphia, infusion of plasma, possibly transfusion. If necessary, fluids are given by mouth or rectum, to control dehydration, but intravenous injections of saline or glucose are more likely to clog the already overstressed tissues than to be beneficial.

Immediate attention is given to the cleansing of the burned area. There is contamination, nearly always, but contamination is not infection. When infection does manifest itself, the reason for it is to be sought.

If the laboratory tests show streptococcus, the origin may be ascribed to conditions within the wound. Where, however, the laboratory reports B, faecalis, pyocyaneus, staphylococcus viridans, there is no escape from the deduction that dirt has been brought to the wound from somewhere along the line of operator, assistants, sisters, orderlies or other attendants; or from cross infection within the hospital; or from the infected air of the particular room; or from failure to eliminate infection in the course of treatment, as when a bath or dressing becomes unsterile.

Here we have one reason for the establishment of special centers, such as the one set up for burns under direction of Colonel Cole-

brook and Dr. Clark at the Royal Hospital, Glasgow, which carries out the idea of centralization as applied to burn cases.

There is, in the nature of things, considerable diversity in burns, diversity as to depth, location and extent. While they all come under the same series of treatments as to shock, sedation, cleansing, control of infection and eventual skin grafting, it is evident that a burn on the face calls for something that may not be demanded in a part habitually covered. A burn on the hand, with its complex attributes of function, presents problems other than would a burn of similar extent on the forearm, for example. And a burn that destroys large areas of skin, as on the neck and chest, the back or abdomen, the arms or legs, or some of these in combination, involves still other agenda.

The hand, if burned, should not be enclosed in a cast. But it is found that when the hand is left uncovered, and supported in the "position of function" or the "position of grasp," immobilization of the arm acts to avert the tendency to disfunction in the hand.

It is believed that excitation of the tissues in which the tendons are imbedded tends to produce the hyperextension and flexion that are typical of these disfunctions, and that immobilization, and the consequent rest to the tissues of the arm, averts this action and leaves the function of the hand undisturbed.

Plaster or crilex applied in this way is a useful adjunct in preparation of a burned hand to receive a graft.

The hand, when ready for graft, is covered, as to every aspect of the burn, palm, back or fingers, by an intermediate graft. If conditions admit, covering of the palm may be by full thickness free graft, as skin of greater density is demanded there than on the back of the hand.

In this covering of the hand, and indeed in grafting in other situations after a burn area has apparently been cleared of infection, for greater security prontosil solution is injected to cover the space between the wound and the graft.

Another method involving complete enclosure of the burn area, is that which is adapted to frequent irrigation of the burn. After

The Bunyan Bag

surgical removal of burnt tissues, and liberal dosing with sodium hypochlorite (Milton) the arm is enclosed in a bag of specially impregnated silk, with inlet and outlet openings, through which there is irrigation three times daily for twenty minutes, with the hypochlorite solution.

Carrel and others recognized an electrolitic quality in this hypochlorite, and it may be that some advantage is derived from this, though it is by no means certain.

The bag protects the wound from fresh infection from outside it, but as the silk substance will absorb some of the bacteria from within, not purged by the irrigation, it is changed after two days and replaced by one that has been sterilized.

The irrigation bag, named for Bunyan in Britain and known in this country as Douglas, depends for its success on the assumption that the sodium hypochlorite solution is as effective a germicide as the sulfa compounds, which it replaces. Concentrations vary from 10 per cent to 50 per cent of the 1 per cent solution in tap water.

But the exponents of this system give sulphanilamide by mouth and may apply the sulphathiazole on the surface if healing by the irrigation process is for any reason delayed.

This constitutes a recognition of the accuracy of the conclusion reached after many tests, namely that sulphathiazole is the most active bacteriostatic, working on a wider range of organisms than sulphanilamide and being more soluble than sulphadiazine.

Sulphanilamide Cream

Preparation of burns for skin grafting by reliance on sulphanilamide is exemplified in the procedure at Glasgow. On admission to the hospital, shock and the cleansing of the burned area have immediate attention.

If the administration of sedative does not suffice, plasma or serum is given intravenously after blood pressure and hemostatic estimation. In emergency conditions the drip may be set up before the

burn is cleaned or the estimation completed, but usually the order is the reverse.

The wound is cleansed with cetyl trimethyl ammonium bromide (Colebrook) in 1.5% solution, applied without anesthetic for three minutes with a mop. To admit of taking a second swab, the wound is washed with sterile saline.

Having in mind the risk of its entering the system or of losing potency through caking, the sulphanilamide is applied in the medium of a cream, from which there is a steady and continuous emanation upon the wound, the purpose being to prevent multiplication of bacteria on the burned area. The cream is compounded of

Sulphanilamide	10%
C. T. A. B.	1%
Castor oil	25%
Beeswax	1.8%
Wool fat	1.8%
Cetyl alcohol	5%
In Water	

This is applied on sheets of gauze, covered with wool, and bandaged. The dressing is left, normally, for from seven to twelve days, and may be renewed for another four to six days if healing is not satisfactory.

If the burn shows exuberant granulation, is grayish, sensitive, with wet discharge and without peripheral epithelization, infection is not under control, and the supreme value of association between operator and laboratory is demonstrated in the location of the reason, frequently traceable to lack of precautions on the part of some member of the operating staff.

Where the persistence of infection, and consequent delay in healing is shown to be due to persistence of hemolytic streptococcus or hemolytic staphylococcus, recourse is had to penicillan. This substance, a derivative from a fungus such as is commonly observed in bread mould, has been given additional value through recent research.

A watery solution, it is mixed with Lanette wax in 30 gram lots, in a concentration of 120 to 150 units per gram.

Spread four times at 48 hour intervals, the mixture causes disappearance of the streptococcus in three or four days. As the action on the bacteria appears to be progressive, rather than immediate, all four applications are made even when healing seems to have occurred earlier. Also, after one or two dressings, recourse may be had to sodium hypochlorite (Milton) in strengths of 1 in 7 to 1 in 20.

If, after sloughing is complete, the burn area is a healthy red, it means that the infection is under control.

Skin grafting follows, the type of graft depending on the size and location of the wound. Something may also depend on the ability of the patient to bear up under the process of raising the graft.

In some cases of weakness homografts may be applied in the expectation that they will last until the patient is strong enough to admit of autografts being taken.

Even if the state of the burn area is not altogether satisfactory, grafting should nevertheless proceed, preferably with pinch grafts or small, isolated patches of epidermic graft. During the spread of epithelization the healing can continue.

I have already mentioned that when the prime object has been attained, and that healing is succeeded by grafting, it is well further to ensure the success of the denser grafts by the injection of prontosil below them.

Grafts in exposed parts, as the face and hands, should not be exposed to direct sunlight, which will cause burns, whose presence is not signalled by the graft, which is without sensitivity. In this connection it should be mentioned that burns about the eyes should have first attention. Eyelid grafts tend to restore the lacrimal contact, and so to save the cornea from the progressive injury to be apprehended from dehydration and exposure. A mask may be used during the healing. Another exceptional case is that of the phosphorus burn, of which a rain of fire bombs produces many.

The burn is immersed in a weak solution of sodium bicarbonate. Obvious particles are removed by forceps. No oil or grease is to be

applied. The burn is next washed with a 1% copper sulphate solution. In the chemical reaction copper phosphide is deposited. This is removed, and the wound dressed. As there may be hidden particles of phosphorus, dry dressings are to be avoided.

Immersion

Burns that destroy large areas of skin, as on the neck and chest, the back or abdomen, the arms or legs, are equally to be made ready for early grafting. This is one of the great advances to the credit of the modern method.

In these cases there may be no epithelization at the wound edges, and the burnt epithelium piles up on the granulation base, infecting it and rendering sterilization difficult. Tannic acid offers no help as infection proceeds below the artificial covering it induces. If the condition of the patient is such that tannic is at the outset necessary for his comfort, it should be removed as soon as possible.

The relative comfort of these patients is best assured by their immersion in a bath of saline solution at blood temperature, after the first treatment of the wound area with one of the sulfa compounds, given in Lanette, and covered with tulle gras.

The immersion brings instant relief from pain, the bandages effect their own removal through the action of the water, and after half an hour or an hour, according to the ability of the patient to bear it without weakness, he is transferred, naked, to a sterile sheet in a tented bed, kept warm by radiant heat lamps, and the burns are covered with sulfa compound, overlaid with tulle gras or vaseline gauze and covered with saline packs.

If there are burns on both back and front, sulphanilamide powder is applied first to the part on which he is to rest. As the immersions proceed, the detritus of the wound can be removed by the attendant with little or no pain to the patient while he is in the water.

He enjoys a freedom of movement in the bath that is not available to him elsewhere. In its comforting, and therefore beneficial influence immersion has been found to avert disturbance of function such as is encountered in other conditions.

Partial immersion can, of course, be achieved by the use of lesser vessels than the bath.

In this handling of very extensive burns the recourse to the pinch graft is likely to be exceptional. It does not do for exposed areas, but does produce a satisfactory covering, admitting freedom of function when the epithelization is complete, on arm, leg or other area not exposed to view, and for which other adequate material for grafting is not to be had.

About sixty of these tiny grafts can be taken from an area six inches square, say on the hip, and as many more from the same area later if necessary. As they are from two to six millimetres in diameter, and are taken a half centimeter or more apart, they will bear distribution over a much larger area than that from which they were taken, when set somewhat farther apart. Sixty or more will give an effective coverage for a burn the length of an arm.

The grafts are so tiny that it is prudent to mark them in blue before raising. When transferred the colour indicates that they are right side up.

So marked, a straight needle is engaged in the epithelial layer, the graft is raised into a small cone, and with a sharp scalpel the cone base is cut at the skin level. It is removed at once, by the needle, to the granulation surface, which has been prepared with saline, but not scraped or shaved.

These grafts, small as they are, include the essential elements of the skin, the outer epidermis, the germinative layer of epithelum that invests the papillae, and something of the upper layer of the corium. Placed carefully against the granulations, with the epithelial edges spread flatly on the surface, they become islands of epithelium from which proliferation proceeds in all directions, in time providing a skin covering for the burn area to which they are applied. A hair dryer is used from time to time to dry the surface and coagulate the serum exuding from the granulations.

The area on which they are imposed is covered with tulle gras, and then by gauze wrung out in paraffin and flavine.

Two or three can co-operate in the work of lifting and applying the grafts. Dressings are removed in a week. If mild infection continues, saline dressings are kept on. Otherwise, tulle gras dressings are again applied.

From this discussion of burn treatment as developed on a grand scale in the present war, the conclusion is that the cleaning, healing and grafting of burn wounds, however great their variety, has become and will remain the accepted surgical practice. There will not be, in future, acceptance for burn treatment that necessitates surgery long afterwards for the correction of distortion or for the restoration of function that need never have been lost.

FAILURES IN RHINOPLASTIC SURGERY

CAUSES AND PREVENTION

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The school of rhinoplastic surgery founded by Professor Jacques Joseph disappeared in great measure with the advent of the Third

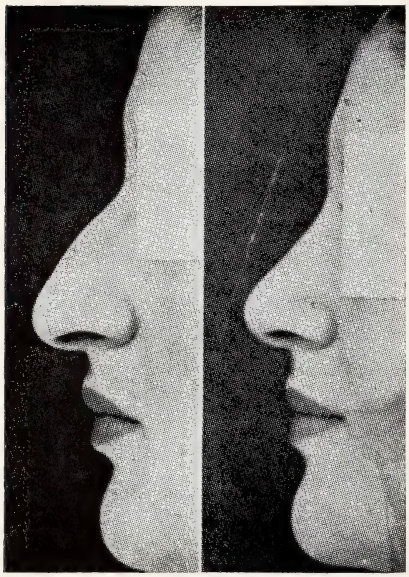

FIG. 1. FIG. 2.
FIG. 1. Convex profile.
FIG. 2. Following correction.

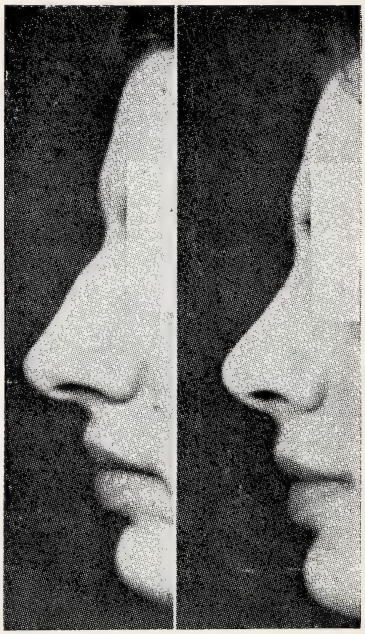

FIG. 3. FIG. 4.
FIG. 3. Prominent profile.
FIG. 4. Following reduction.

Reich, when he became an exile and died shortly thereafter. Teaching facilities in this branch of surgery became restricted because only a few men were able to associate themselves with the small group of Joseph's pupils in this country.

Lectures, scientific publications and demonstrations of patients during a decade or more have convinced the medical profession that a profound psychologic factor is involved when a nasal disfigurement is either properly or improperly corrected. When rhinoplastic procedures gained the approval of the medical profession, the demand for the correction of nasal and other facial disfigurements became increasingly great.

Plastic surgery, and rhinoplasty in particular, present a dual problem. First, the technique must be mastered as in all surgical procedures; second, equally or even more important, is the art of creating "form" which has a definite esthetic value. Success in rhinoplastic surgery, therefore, depends upon a combination of surgical training and an innate creative ability. Because the essential artistic instinct is a personal faculty, it accounts for the varied attainments of even well trained men.

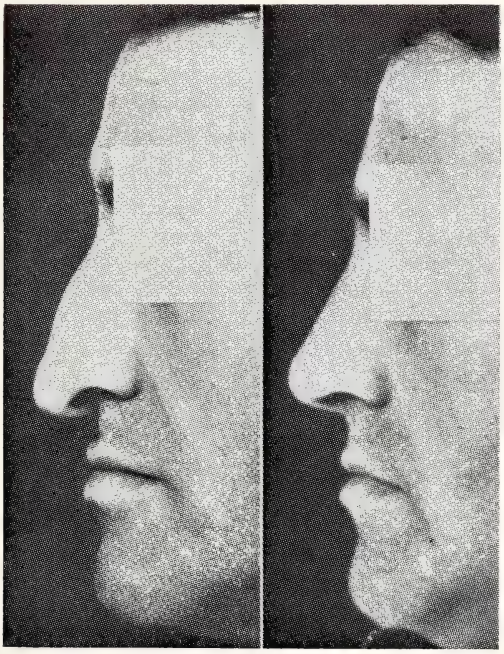

FIG. 5. FIG. 6.

FIG. 5. Long humped nose.
FIG. 6. Normal proportion following correction.

The admittedly large proportion of unfavorable results following rhinoplastic operations is a definite indication that the majority were done by men lacking in one or the other of the essential qualities. Some results show ample evidence that both pre-requisites were lacking. The patients often suffer secondary surgical disfigurements, varying in degree from an unnatural appearance to actual mutilations. It is difficult to exaggerate the great injury inflicted and the social and economic loss.

The patient who submits himself to a rhinoplastic operation does so with the expectation that the disfigurement which is a hindrance to economic or social progress will be eliminated and a normal nose, conforming to general esthetic conceptions, will result.

The esthetically normal nose is in proper proportion to the other facial features in length, breadth, and profile elevation. An important element of a satisfactorily reconstructed nose is that it must

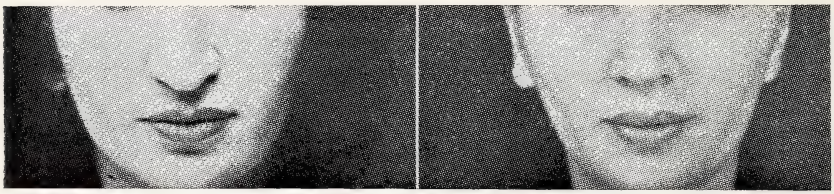

FIG. 7. Long nose with wide hanging tip.
FIG. 8. Normal appearance of tip following correction.

not show evidence of having been operated upon. One must particularly avoid what is commonly known as a "surgical nose."

The first group of cases illustrated here shows the various types of nasal disfigurements before and after correction. Particular attention is called to the normal appearance of the corrected noses and especially to the fact that the nasal tip retains the normal esthetic curves provided by nature. (Figs. 1 to 8.)

An analysis of rhinoplastic failures shows that they usually fall into one or more of three groups. The secondary surgical disfigurement involves either the upper, middle or lower third of the

nose. The individual steps of a complete rhinoplastic operation can be considered and the more common errors which lead to unsatisfactory, and sometimes truly amazing results, can be pointed out. This study is based on my experience with a large number of patients who sought physical and emotional relief from an unsatisfactory rhinoplastic operation or from a secondary surgical deformity.

1. *The Upper or Bony Third of the Nose.* In this category the surgeon is usually concerned with the removal of a nasal hump, or the lowering of the profile line and the narrowing of the nasal bridge.

The errors commonly committed which lead to poor results are as follows: (*a*) the removal of bony structure without a compensative reconstruction of the rest of the nose, resulting in a bird-beak effect (Fig. 9); (*b*) cutting through the right and left side of the nasal hump at unequal levels, producing a flattening of one side or the other; (*c*) failure to cut the dorsal edge of the

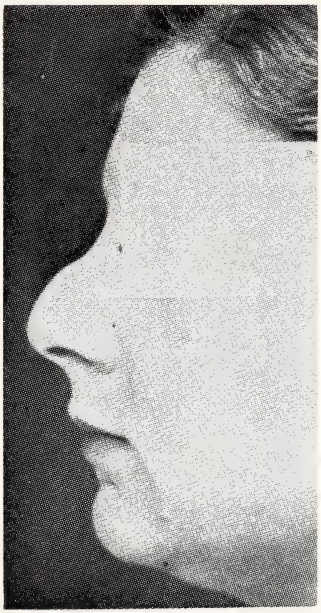

FIG. 9. Bird beak effect due to incomplete operation.

septum down to the same level as the lateral walls, producing a "razor edge" nasal dorsum instead of one with a normal width; (*d*) failure to narrow the nasal bridge, resulting in a flat dorsal plateau with retraction of the skin into the hiatus created by the removal of the hump (Fig. 10); (*e*) failure to produce a complete fracture of the lateral walls, tending to widen the nasal bridge; (*f*) deviation of the bony septum, preventing a proper "in-fracture" of the affected side, resulting in a scoliosis; (a deviation of the bony septum must always be corrected prior to any attempted narrowing of the nasal bridge) (Fig. 11); (*g*) cutting through

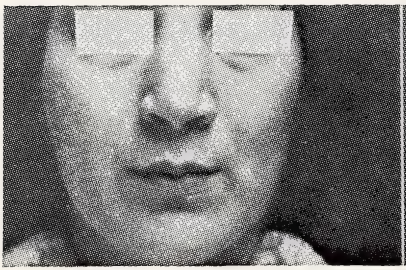

FIG. 10. Failure to narrow nasal bridge.

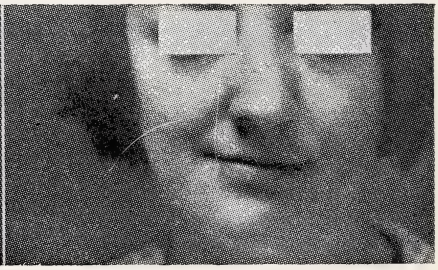

FIG. 11. Failure to correct septal deformity prior to plastic correction.

the frontal processes of the superior maxillae at an improper level, producing a step-like thickening at the base of the nose.

The surgeon who undertakes to perform rhinoplastic operations must realize from the foregoing axiomatic statements that an exacting technique is of prime importance and that any slight deviation therefrom or error of judgment regarding measurements, proportions, or position, will produce a disappointing result.

2. *The Middle Third of the Nose.* This consists of the lateral cartilages and the septum.

A nasal hump, or an excessive profile elevation, is rarely confined to the bony structure alone. The cartilages of the middle third of the nose are usually an integral part of the nasal hump and these structures must therefore be brought down to the newly created level of the bony part.

Errors are: (*a*) failure to level the septum to the required profile line, leaving a cartilaginous hump or a dorsal convexity (Figs. 12 and 13); (*b*) the lateral cartilages must be trimmed down to

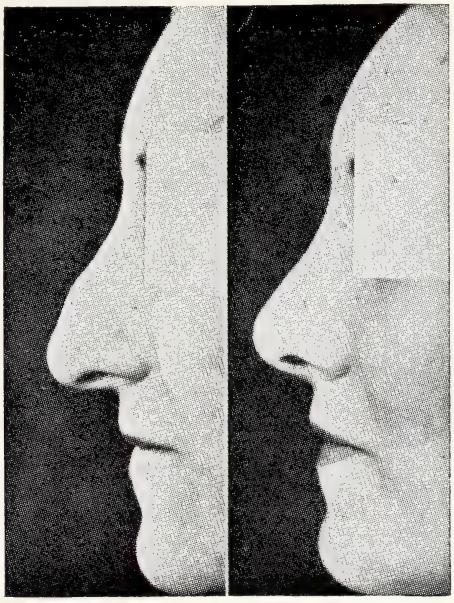

FIG. 12. FIG. 13.

FIG. 12. Failure to level cartilaginous hump to level of bony correction and insufficient shortening of nose.
FIG. 13. Same patient following secondary operation.

the newly leveled septum, because failure to carry out this step leaves an elevation on one or the other side of the midsection of the nose; (*c*) the lower portion of the lateral cartilages must be trimmed in order to reestablish a normal relationship between the lateral and alar cartilages. If this trimming is not carried out an excessive thickening of the nasal tip results, with an obliteration of the nasal vestibule. (Fig. 14.) It is important to bear these points in mind in order to avoid an unsightly secondary disfigurement after an otherwise properly performed nasal correction.

The necessity for a secondary correction following a primary

FIG. 14. Lower end of lateral cartilages curled up and producing a thick nasal tip.

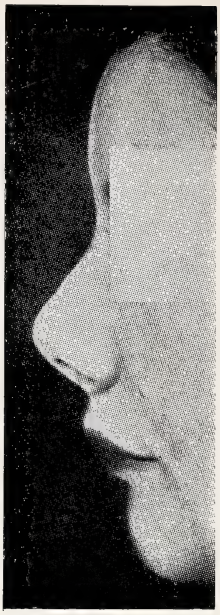

FIG. 15. Excessive shortening of the nose.

rhinoplasty is not always an indication that the original correction was improperly performed, provided no surgical disfigurement results.

The conservative surgeon makes a sufficient allowance for the normal dropping of the nasal tip after the primary shortening. But the exact degree of dropping cannot always be anticipated, because the muscular action and tonus of the labial muscles vary in different individuals. (Fig. 15.)

A secondary shortening of the nose is indicated in about 10 per cent of patients. Other secondary corrections which may aid in the final satisfactory result are, either an additional narrowing of the nasal tip or of the nostrils.

3. *The Lower Third of the Nose.* It will be obvious from the foregoing that great caution is necessary in corrections involving the lower third of the nose. It is in this area that the largest

number of surgical disfigurements occur. The cartilages comprising the lower third of the nose have, aside from other functions, one definitely esthetic. The cartilages may be too large or disproportionate. Faulty technique or disregard of the anatomic functions of the cartilages will always result in a distinct surgical disfigurement. We see more patients with surgical disfigurements or mutilations of the nasal tip, than with any other type of secondary rhinoplastic deformity. The end result in the correction of these mutilations depends upon the degree of destruction of vital nasal tissues. When the disfigurement is slight a considerable measure of improvement can be brought about, while the more flagrantly distorted noses are almost beyond repair.

I have described[1] the most satisfactory techniques employed in corrections involving the lower third of the nose to avoid the most common errors.

(*a*) In shortening the nose, the watchword should be *conservatism.* The nose should be shortened to an extent somewhat less than the length of the chin line. The usual amount of postoperative droop is about 2 mm. When it exceeds this, it is preferable to carry out a secondary shortening, following which there is usually no postoperative dropping of the nasal tip.

(*b*) The narrowing of the nasal tip should be carried out with the objective in mind that sufficient alar cartilage and mucosa must remain to afford proper support for the overlying skin. The commonly observed pinch-tip effect will thus be avoided. The alar cartilages should never be removed completely. (Figs. 16 and 17.)

(*c*) A rather common surgical disfigurement is a retracted

FIG. 16. Pinched tip and failure to shorten hanging columella.

FIG. 17. Shrinkage of tip due to complete removal of alar cartilages.

columella. This effect is produced by the removal of the posterior surface of the columella while shortening the nose. (Fig. 18.)

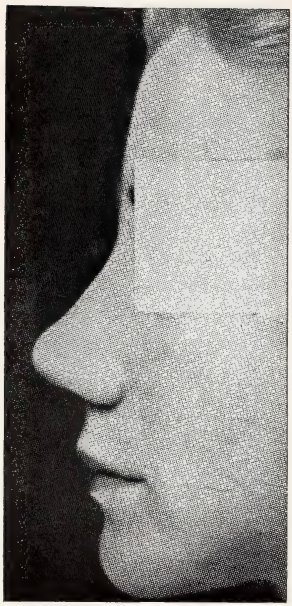

FIG. 18. Retracted columella.

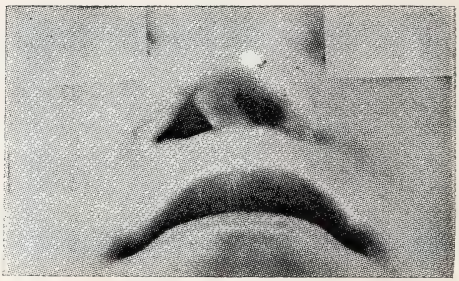

FIG. 19. Mutilation due to improperly performed Weir operation.

Such a deformity is not easily remedied because a supporting structure has been lost. It seems to me that the error is made with the assumption that a "hanging septum" can be corrected by removing the posterior half, or more, of the columella. As a matter of fact the "hanging septum" is merely an excessive convexity of the anterior edges of the columellar cartilages. When this condition is present it calls for specific correction, the technique for which is described in my book,[1] as well as in Professor Joseph's "Die Rhinoplastie."[2]

One step in a general rhinoplastic correction which requires careful consideration is the reduction of the size of the nostrils by the excision of a triangular section, anteriorly or posteriorly. During the operation one may get the impression that the nostrils appear larger than before. This is frequently due to the novocaine

infiltration, and subsides after the solution is completely absorbed. I have observed many instances where the base of the nose, in a previous operation, was unnecessarily narrowed, resulting in a typical adenoidal facies. Unless one is certain that this step is indicated it is best to defer it until all swelling has subsided. It will

FIG. 20. Mutilation of nasal tip due to improper surgical technique.

FIG. 21. Same patient following a series of corrective operations.

then rarely be found necessary to reduce the size of the nostrils. As a rule, the narrowing of the nasal tip, according to the technique described in my book, will diminish the size of the nostrils sufficiently to make the second operation unnecessary.

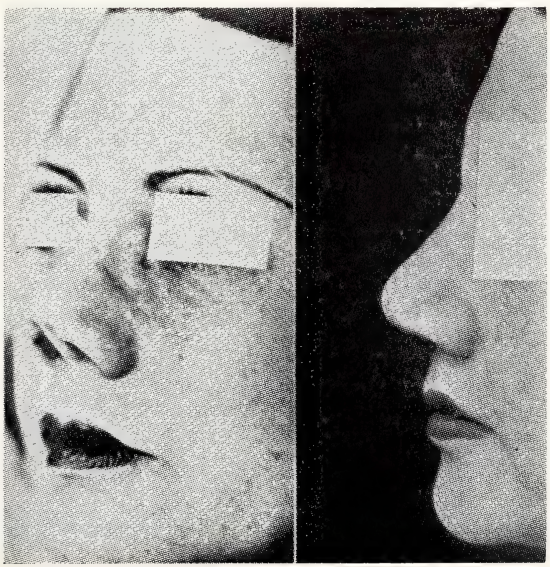

FIG. 22. FIG. 23.

FIG. 22. Profile view of the same patient in Figures 20 and 21.
FIG. 23. Profile view following correction.

Another alar operation which is far too frequently performed is what is commonly called the Weir operation. It consists in the excision of a crescentic section of the alae at their attachments.

FIG. 24. Mutilation of nasal tip due to improper surgical technique. Front view.

FIG. 25. Same patient following a series of corrective operations.

This is indicated only in persons with true negroid nostrils. In all other instances which I have observed, this operation flattens the nostrils and obliterates the nasolabial fold. It constitutes a surgical

FIG. 26. Same patient, as in Figure 24, profile view prior to secondary correction.

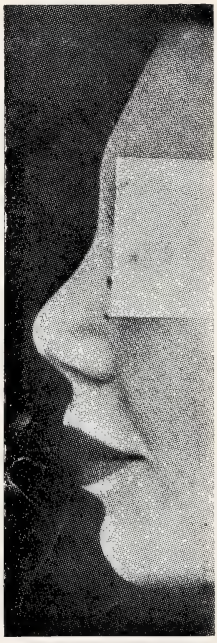

FIG. 27. Same patient profile view following secondary correction.

deformity which, as far as I am aware, has not been successfully corrected by a secondary operation. (Fig. 19.)

Conclusions

I ardently advocate conservative surgery even if the necessity for a slight secondary operation should arise and if the esthetic requirements of the patient demand it. It is obvious, however, that the primary operation must produce a decided improvement in the patient's facial appearance.

When the primary operation is unskillfully performed and a definite surgical disfigurement is produced, it may require a series of secondary operations, each more difficult and complicated than the original one before the patient can be restored to economic

FIG. 28. Failure to approximate the columellar cartilages.

FIG. 29. Following corrective operation.

usefulness, or saved from a state of physical depression and a life of social ostracism. Unfortunately, some of these patients are so severely mutilated that they cannot return to their gainful occupation, especially if a "presentable appearance" is requisite. Figures 20 to 29 are examples of severe surgical mutilations of the nasal tip and the results obtained after a series of corrective plastic operations.

Reference

[1] Safian, J. Corrective Rhinoplastic Surgery. New York, 1935. *The American Journal of Surgery, Inc.*

[2] Joseph, Jacques. Die Rhinoplastie.

RECONSTRUCTION ABOUT THE NASAL TIP

By CLAIRE L. STRAITH, M.D., F.A.C.S.
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Reconstruction of the nasal tip has been a subject of surgical interest for at least three centuries. It is a historic fact that the early Hindu efforts (1500 B.C.) to replace severed noses by the well-known forehead flap (Indian) method constitutes one of the earliest chapters in the history of plastic surgery — if not of the general art of surgery itself. In the Middle Ages, when sword fights were the order of the day, a second era of plastic surgery was inaugurated by the celebrated, much-traveled Italian Tagliacozzi, who utilized arm flaps for his reconstructions. The third era received its greatest impetus from the World War and its countless wounded. Interest in the art of rhinoplasty was revived. Hitherto unparalleled opportunities were provided for surgeons to perfect old and devise newer methods. The fourth epoch is in the present or automotive age with its countless accidents resulting in crushing and mutilating injuries about the nasal tip.

Intense interest of the present day in this phase, as in all phases of plastic surgery, is a result of the keenly competitive nature of modern life which places a large premium on personal appearance. An enlightened public, moreover, has learned that correctible deformities or even blemishes, whether congenital or acquired, need not be borne through life with "patient resignation." A more enlightened profession is realizing that complexes (inferiority, criminal, etc.) are the sequels. "Patient resignation" without a resultant character or personality blemish is the exception rather than the rule.

Reconstruction of the nasal tip is indicated: (1) in the presence of acute laceration; (2) in the presence of tissue loss (trauma, disease) involving skin covering, nasal lining or nasal supporting structure; and (3) in the presence of cosmetic deformities (con-

genital or secondary to inadequate or incomplete repair of previous trauma).

Lacerations about the tip of the nose should receive special attention, since the nasal skin, often coarse and filled with large pores, carries potential infection. For this reason, no large suture material should be used due to the frequency of wound infections in this area, as well as the conspicuousness of resulting stitch marks. If such lacerations are sutured with "figure-of-eight" stitches beginning within the nose (thus removing all tension from the wound), the surface need only be approximated lightly with fine horsehair

FIG. 1. Lacerations about the nose are common injuries sustained by the guest passenger in the front seat of an automobile due to impact against the instrument panel studded with projecting knobs, gadgets, etc. Note the laceration involving the columella, tip and lower half of the nasal bridge. Nasal skin is so prone to infection that better results are obtained by the use of "figure-of-eight" stitches tied within the nose to remove tension, and horsehair subcuticular stitches on the surface for skin edge approximation. This eliminates stitch marks on the surface.

FIG. 2. The use of "figure-of-eight" stitches as illustrated above, to relieve tension in nose, lip, and cheek wounds, helps greatly in minimizing scars from stitch marks. The stitch is started and tied on the inner surface and does not come out on the skin surface. It produces a very close approximation of the wound edge so that a simple subcuticular stitch is often sufficient on the surface.

(subcuticular or interrupted) stitches which leave no marks. If preferable or desired, interrupted horsehair sutures with only the first double twist of a surgical knot tied on each stitch may be utilized. If these sutures are removed on the second or third day, no stitch marks should result. (Figs. 1 and 2.)

In motor accidents, glass cuts often sever portions of the nasal skin. Small areas can be replaced at once by a Wolfe graft taken from the upper eyelid or from behind the ear. A lead or tin foil pattern of the lesion should be made and the graft cut to size and

FIG. 3. Loss of skin over the nasal tip due to motor accident. Immediate skin graft taken from back of the ear was sutured in place with fine silk sutures (upper insert) leaving the ends long for tying over gauze pad to produce pressure on graft (lower insert). Note also, subcuticular stitch in upper lip wound to minimize scarring. The graft "took" in its entirety, as shown in after photograph taken some three weeks later.

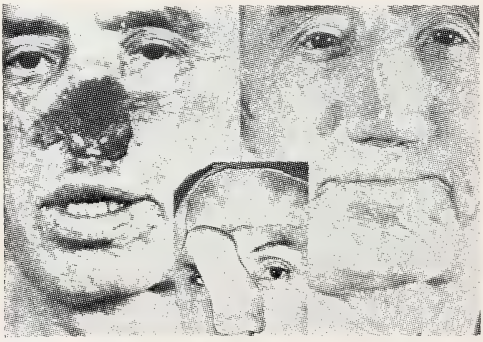

FIG. 4. Indian method of rhinoplasty. This nose was excised in the treatment of a carcinoma. Insert shows forehead flap transferred to nose and Thiersch graft replacing denuded forehead. After-photograph shows the nose following rib cartilage transplant to the nasal bridge and also a support to the columella.

denuded of all fat. The graft is then sutured in place with horsehair or small silk, the ends being tied over gauze to produce pressure on the graft. The use of this method necessitates a freshly denuded surface upon which the graft may rest. If pressure is maintained for about eight days most such grafts will take. The patient is thereby saved much delay as well as subsequent operative treatment. (Fig. 3.)

Full thickness losses of the nasal covering demand replacement

FIG. 5. Author's method of nasal replacement. This nasal tip was severed in an industrial accident. A tube pedicle was constructed on the neck to bring up the skin just behind the right ear (first insert). After two weeks this was attached to the nose and left in place for seventeen days (second insert). Following the severence of the pedicle the tip was reshaped to assume the appearance in the final photograph.

FIG. 6. This nose was severed for the removal of an epithelioma of fifteen years' standing. Lining flaps were outlined on the cheeks and later inverted. Inserts show pedicle before and after transfer to the nose. Final photograph shows result accomplished by this method. The author has used the method in patients from 2½ to 75 years of age, and in both males and females, and finds that the results are very satisfactory.

of both covering and lining and, in some cases, the insertion of supporting material as well. The choice of skin areas for replacement is important. Skin for transfer to the nose should be hairless and, if possible, should closely match the facial integument. These requirements limit the choice of graft material decidedly since skin from other parts of the body will not match that of the face. Forehead skin has been the choice of most surgeons for centuries since it provides ample skin which is both hairless and of good color. It has serious disadvantages in male patients, however, due to the resultant scarred forehead, no matter how nicely the forehead is grafted or sutured. (Fig. 4.) In women, the method is excellent because forehead scars can be readily concealed by the hairdress.

The Italian method (using the arm skin) has the great disadvantage of bringing skin to the nose which does not match that of the face. The uncomfortable position which must be maintained for two to three weeks while the armskin is grafted to the nose, is another serious objection to this method.*

Because of the disadvantages of a scarred forehead as a result of the Indian method and the poor color of the graft when the arm skin is used, I have advocated the use of a tube pedicle from the neck as a means of bringing to the nose, skin lying behind the ear and between the scalp and beard hair line. This furnishes skin for facial repairs that matches the face, is practically devoid of hair and leaves only an inconspicuous scar on the side of the neck. This method is particularly useful in males who have a partial loss of the nasal skin or of other areas in the lower half of the face. (Figs. 5 and 6.)

For smaller areas about the tip or alae of the nose, ascending (Fig. 7) or descending flaps (Fig. 8) along the nasolabial fold are

* Franklin Martin, in his book, "South America," records an interesting incident regarding Don Pedro de Heredig, founder of Cartagena, Colombia. "Upon a certain night while out bent on a gallant adventure in the narrow and divided lanes on the outskirts of his native village, he was attacked by six gentlemen. These gentlemen so badly impaired Heredig in the affray that he lost his nose and afterwards it was restored by the medium of rhinoplasty, using the fleshy part of one of his arms." The story continues and states that "now cured, but finding his once comely nose deformed and of bad color, Heredig, burning with wrath, sought out his aggressors, challenged them in unequal combat and killed three of them." He relates this as an example of the plastic art in Spain as early as 1520.

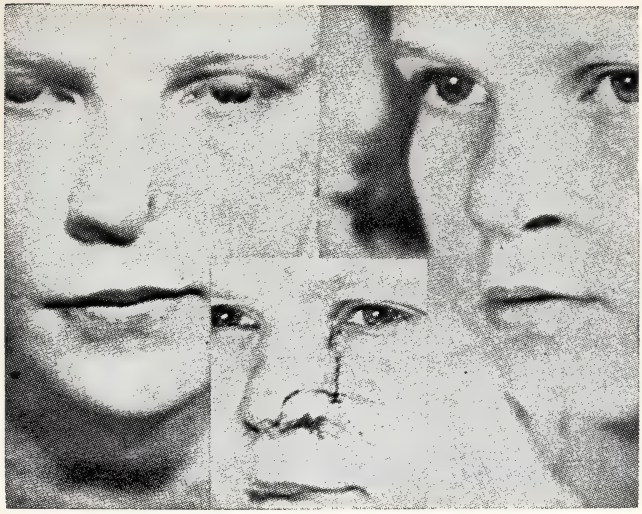

FIG. 7. Congenital loss of left ala repaired by an inverted flap of surrounding skin to produce lining and covered by an ascending flap from the left nasolabial fold. Note that subcuticular stitches are used to minimize the amount of stitch marking. The final result shows an ala reconstructed of well-matched facial skin and very little secondary scarring.

FIG. 8. A v-shaped piece of skin had been cut from the base of the left ala in an accident. There is a maxim in plastic surgery which holds true with few exceptions, "Never distort tissue to close a defect." In this case the rule had been disregarded and the balance of the ala had been pulled down to the cheek to close the defect. The tip of the nose was deviated and both nostrils practically closed. To repair the loss and supply both lining and covering, a descending flap was elevated and resutured with subcuticular stitches to avoid transferring "second-hand stitch marks" to the nose (upper insert). Two weeks later the ala was detached and the tip of the flap rolled in to supply lining and the surface covered by the flap (lower insert). The final result shows a well-matched graft and a very slightly noticeable nasolabial scar.

of great value. In each case, however, a lining flap must be provided either by inturned flaps from the surrounding skin or by a free graft applied to the under surface of the flap before it is brought into position.

Loss of the cartilaginous support about the nasal tip is usually due to infections or accident. Lues may cause a septal abscess affecting the nasal tip cartilage, septum, etc., but is more likely to involve the bony structure and result in a saddle deformity in the upper half of the nose. Complete destruction of the septum and

FIG. 9. Small alar deficiencies can be corrected by pedicle transfers from the lateral nasal wall. The above photographs show the correction of a notched ala by a simple z plastic.

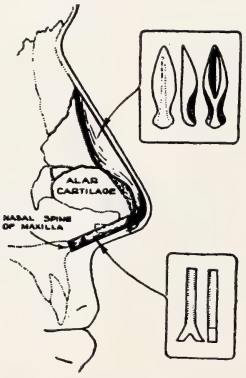

FIG. 10. Rib cartilage, whether autogenous or preserved, should be shaped accurately to give the most pleasing result. The cartilage should be rounded on the top and tip, and usually beveled at the end to form an inconspicuous joint at the end of the nasal bone. We undercut the side of the lower part of the cartilage to permit it to fit over the alar cartilage. The vertical support can be notched at the base so that it will straddle the nasal spine. The two pieces are sutured with fine plain catgut.

nasal lining may cause a complete collapse and inversion of the nasal tip. Intensive antisyphilitic therapy must, of course, be carried out before surgical reconstruction is attempted.

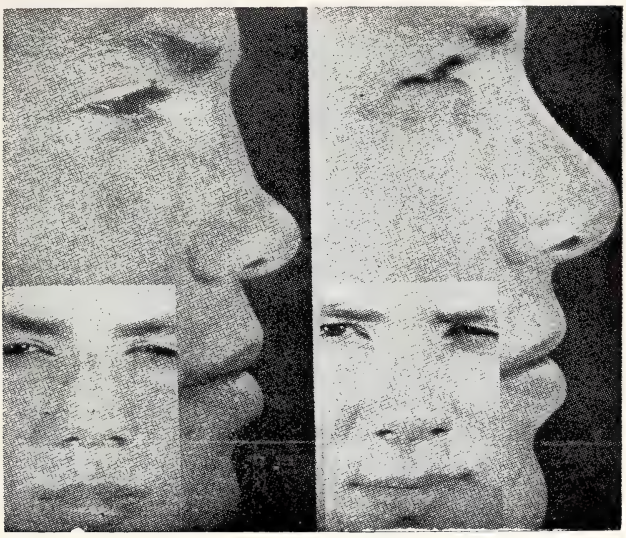

FIG. 11. Typical depressed nasal tip which may be caused by accident, septal abscess or occasionally follow septal resections where no tip support is left. The correction was made by the use of preserved cartilage support inserted through a midcolumellar incision in the manner illustrated in Figure 10.

FIG. 12. Bulbous, prominent nasal tips are common deformities. The reduction can be made by careful dissection of the cartilages through intranasal incisions. The above patient had some enlargement of the nasal bridge which was reduced, but the marked enlargement of the tip constituted the greatest deformity. The reduction of this nose produces a very much improved appearance and always adds to the happiness of the patient.

Traumatic injuries to the lower half of the nose may cause fracture of the septum or septal abscess, resulting subsequently in a depressed flat nasal tip. Accidental removal of too much septal cartilage in septum resections when no "post" is left anteriorly is another frequent cause of nasal tip deformity.

The reconstruction of the depressed nasal tip requires the insertion of some form of support. Many materials have been tried, such as ivory, celluloid, paraffin, bone, etc. In my experience, rib cartilage is far superior. The use of this material has undergone an interesting transition. It was first thought that only the patient's own cartilage could be used (autogenous graft); later it was found possible to use cartilage from one person for the repair of a lesion in another (isograft). Since the excellent work of O'Connor and Pierce in preserving human cartilage, it is now possible to preserve cartilage acquired from autopsies (where tuberculosis, lues, cancer, etc., have been ruled out) for months at ice box temperature. This material can be used with little fear of reaction. If infection supervenes, pre-

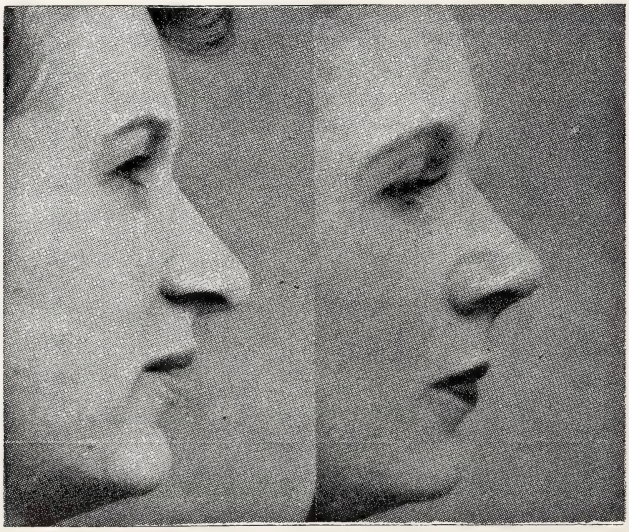

FIG. 13. An acute angle between the tip of the nose and the lip is always conspicuous. A long over-hanging nasal tip such as the one above can be shortened, changing this angle to about 10 to 20 degrees above a right angle. A much prettier profile is produced.

served cartilage grafts appear to be more resistant than autogenous material.

The use of preserved cartilage eliminates the dangers of a rib resection and also permits one to correct such deformities in children at an early age before they are subjected to the taunts and ridicule of thoughtless playmates.

In slight depressions of the nasal bridge just above the tip, a single piece of shaped rib cartilage can be inserted through a mid-

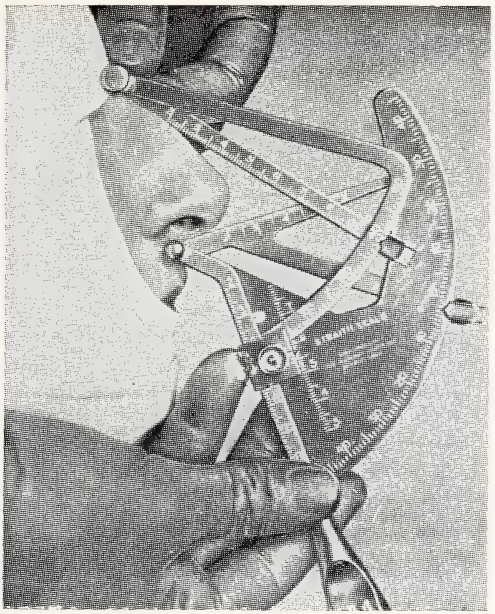

Fig. 14. Author's profilometer: To aid in more accurately reconstructing the nasal contour the author has devised a profilometer which is used in all rhinoplastic operations. The bridge of the nose should project at about 30 degrees from the vertical plane of the face (profile angle). The tip should be tilted from 10 to 25 degrees above the horizontal (tip angle). The length of the nose should be a little less than the distance from the end of the nose to the chin. All of these angles can be measured with this instrument. (In the above illustration the profile angle was 39 degrees, tip angle negative 3 degrees and length of nose 5.8 cm.).

At operation the profilometer is set for the proper angle and the nasal hump reduced to this level. The tip is then elevated and slightly overcorrected to allow for subsequent dropping. By the use of this instrument as a guide, the nasal contour can be "cut down to scale" more accurately than was formerly possible.

columellar or other incision into a tunnel prepared for it. If a proper splint is applied to prevent hematoma formation, such transplants give excellent results.

Depressions involving the tip require a transplant to support the bridge and vertical post transplant from the maxilla upward to form a solid buttress on which the tip of the horizontal transplant can rest. (Figs. 10 and 11.)

Variations in the form of the nasal tip are numerous. Many of these variations are sufficient to be designated as real deformities. Their correction constitutes a large part of cosmetic rhinoplastic surgery.

Such nasal deformities are due in large part to an overdevelopment of the nasal cartilages. This may result in a very prominent dorsum of the nose (Fig. 12), abnormal breadth of the tip called the "potato nose," excessive length of the nose with an unsightly hanging columella, or in an overhanging nasal tip. (Fig. 13.) Old fractures may result in a twisted nasal tip.

In all such deformities, the overdeveloped cartilages must be reduced to normal by removing the excessive amount through incisions within the nose so that no scar will result. These corrections bring a great improvement in appearance. Although less formidable than other rhinoplastic procedures, this type of nasal tip surgery is much more exacting, and technically more difficult, than that involving the bony nasal structures.

The nostrils also vary greatly in size and shape. They may be too wide, too long, too short, flat or collapsed. Many of these varied conditions can be altered and improved by plastic procedures.

Conclusions

The importance of reconstructive surgery of the nasal tip cannot be overemphasized. Such deformities are often very conspicuous and occasionally the only blemish to an otherwise handsome face. The correction of these defects in expert hands now offers very little difficulty for the patient; the danger of infection is negligible

and, properly performed, the operations almost always result in a greatly improved general appearance.

The beneficial effect on the mental attitude of the patient is of even greater importance. A comparatively simple operation, performed under local anesthetic, often relieves the patient of a deformity which has been a source of mental agony for years. The counsel of "patient resignation," too often given by physicians and friends, is unkind and unsound in the light of recent surgical achievements in this field.

The patients, if encouraged to have their deformities corrected, are usually eternally grateful. They soon overcome inferiority complexes and begin their rightful pursuits of happiness.

NASAL ATRESIAS

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Very little emphasis has been placed on atresias of the nose, nasopharynx, oropharynx, etc. as a sequelae to the repair of war wounds in these areas.

Atresias in these areas may result directly from the wounds. Mucous membranes when destroyed heal with scar tissue. This scar tissue may be sufficient to cause enough contraction in its process of repair that atresia may be incomplete or complete.

There are three forms of atresia, the osseous, membranous and osseous membranous. They may be unilateral or bilateral. They may be congenital or acquired. Here we are only interested in the acquired forms as a result of war wounds or a sequelae to the plastic repair of war wounds.

Atresia of the Anterior Nares

The membranous type is the most common form encountered in the anterior nares. With the advent of rhinoplasty and reconstruction surgery about the tip and nares of the nose, atresia is not uncommon. In the rhinoplasties too much mucous membrane was removed whereas in the reconstruction, this mucous membrane has already been destroyed or damaged.

This type does not present any problem in diagnosis. Anterior rhinoscopy readily reveals the pathology.

These patients have difficulty in breathing and if not corrected, secondary sinusitis usually follows with the concomitant effects upon the physiology of the nose and the eustachian tubes.

THERAPY. — Various methods have been recommended for the correction of this malformation, among them electrocoagulation, incision and packing, and excision of atretic membrane with insertion of a rubber tube. These methods have proved futile for the

most part because contraction of the resulting granulation tissue causes shrinkage of the nasal opening. However Joseph,[1] Kirschner,[2] Dewey,[3] O'Connor,[4] and Blair[5] have prevented contraction and obtained succesful results by using a Thiersch graft to line the raw area of the nares after excision of the atretic membrane.

The technique of repair is the same for complete or incomplete atresia. It is best done, with a minimum of bleeding, under local anesthesia. Dissection of the entire atretic web is essential. In order to have a rigid background for implantation of the coming graft, it is necessary to remove every vestige of pathology, exposing the alar cartilage with its crura, the upper lateral cartilage, the apertura piriformis and the septum. When this is done a large raw area presents itself. It is absolutely necesary to give this an epithelial covering; otherwise granulation tissue followed by cicatricial tissue will produce a greater deformity than the original condition. Blair's split graft is our procedure of choice.

An over-impression of the denuded area is made with a soft rubber tube. The split graft is placed around this tube, raw surface exposed, and its edges are sutured. It is then placed in situ. It is essential that this graft be well immobilized; otherwise it will not take. Another important point to remember is that there must be some over-correction to allow for a certain amount of contraction which is inevitable in spite of all precautions. The softness of the tube will prevent any possible pressure necrosis.

The nose is kept clean postoperatively by passing a small rubber catheter through the tube and removing all secretion and debris by dry suction. This is followed by instillation of metaphen and neosynephrin for antisepsis and aeration.

The tube is removed in ten days, and the area is inspected and cleaned. A new epithelial lining of the nose should now be presented.

The newly created cavity must be further treated with dilatation and immobilization; otherwise there will be great shrinkage and contraction. The same tube cleaned, or another like it completely filling the new spaces, should be reinserted for at least another ten days.

When the support is removed at the end of this interval, all granulating tissue should be coagulated. A certain amount of contraction will eventually take place, but this has been provided for by the over-correction.

Recently the writer has been using the black mold of dental stent. The raw surface exposed after the atresia has been removed, the soft dental stent is placed over the entire area for outline. It is removed and a split graft is patterned in the same fashion, placed on the stent with the raw surfaces exposed and then inserted into the nose covering the entire raw surface.

Similar dental stent is applied externally corresponding to the same area. These two stents are immobilized by double mattress sutures of heavy black silk and tied externally interposed with a layer of gauze.

This technique avoids any necessity for packing and is much easier on the patient. Keeping the nose clean becomes an easy procedure. The stent is removed after ten days when the graft will have taken and the procedure from then on is the same as described above.

Choanal Atresia

Otto,[6] in 1829, was the first to discover a congenital obstruction of the posterior nares, quite accidentally, while performing an autopsy. It was not until 1853 that the first surgical case was reported by Emmert,[7] in a boy seven years old. The obstructing mass was eradicated with the use of a curved trocar, and this technique prevailed until 1885 when von Schroetter[8] reported the successful use of electrocauterization in choanal atresia. This was immediately followed by the employment of many different chemical caustics.

Uffenorde,[9] in 1908, was the first to advocate surgical removal of the choanal mass by means of chisel and curette, through the nasal septal route. This method was soon discarded.

Katz[10] in 1913 and White[11] in 1919 advocated the technique of removing the obstructing wall first and then taking away the posterior part of the vomer. This is perhaps the method of choice today.

Blair,[5] in 1931, was the first to introduce skin grafting. He used a large split graft sutured around a tube, with the raw surface of the graft coming in direct contact with the raw surface of the choanal region after eradication of the obstruction. In 1938 Donnelly reported a case of right-sided choanal atresia corrected by the use of a full thickness graft sutured around a No. 18 French woven catheter.

Diagnosis of this condition is relatively simple because of the many physical means at our disposal to ascertain the pathology. Insert some methylene blue into the nose and extend the head slightly backwards. If the methylene blue does not pass into the nose and oropharynx, complete atresia is the cause. If the solution trickles into the nasopharynx very slowly, incomplete atresia is present. If the solution passes rapidly into the nasopharynx, no atresia is present. This procedure is done on both sides at different intervals. Posterior rhinoscopy will confirm the physical findings. Digital exploration is important. A new sensation is imparted to the touch, never before experienced. It is altogether foreign to the sensation imparted from adenoidal vegetation.

THERAPY. — Treatment appears to present a more difficult problem, chiefly because the individual surgeon is rarely confronted with these cases. When he does encounter one and refers to the literature, he is likely to be confused by the diversified procedures advocated.

If we bear in mind the underlying pathology, it is not difficult to adopt suitable corrective measures. In the unilateral type of atresia, operation may not be necessary. Most often these cases are recognized by chance upon routine examination without the patient's pre-knowledge of the condition. Surgical correction depends upon the underlying pathology, as will be seen in the bilateral type.

This type of operation is governed by the nature of the atresia. If the choanal atresia is osseous, mere perforation of the mass to create an opening is usually insufficient. Many ingenious devices have been utilized to maintain this postoperative patentcy, such as tubes, obturators, catheters, post-nasal tampons, impregnated medicated gauze strips, etc. However the surgically created aperture

usually closes after several months because of the stubborn nature of the osseous occluding growth. Blair's technique of skin-grafting this type of atresia is unquestionably the procedure of choice.

The important fact to remember is that the field must be absolutely dry before applying the skin graft. Even a small blood clot is sufficient to cause failure. The opening should be perfectly smooth so that the graft is snugly adherent to the exposed raw surfaces.

Another important requirement is that the graft should have complete immobilization; otherwise it is certain to slough. The graft is kept in place on a rubber tube or French catheter for at least 10 days before the support is removed. A split graft is more certain to take than full thickness graft.

Almost any instrument can be used to remove enough of the mass for the implantation of the graft. Most commonly employed are the trocar, chisel, hammer, curette, dental burr and drill.

In removing any atresia it is most important not to injure the mucosa of the nasopharynx. This can easily be prevented by inserting a choanal plug, or if necessary the left index finger, into the nasopharynx.

In the membranous form of choanal atresia good results are obtained by removing surgically a large portion of the obstruction and the posterior third of the septum and following this at a later date with electrocoagulation for future granulations.

A sphenoid punch forceps should be sufficient to remove a large portion of the atresia. The posterior third of the septum, including the vomer and the lower section of the perpendicular plate of the ethmoid, is then removed in order to give plenty of room. A choanal plug impregnated with balsam of Peru and castor oil (as in posterior nasal bleeding) is snugly inserted into the large created opening and fastened securely to the auricle. This choanal plug seldom causes any otitic complications. It is easy to manipulate and not too annoying to the patient.

On the ninth or tenth day, when the second packing is removed, the created space is thoroughly cleaned with sprays and irrigations. Under strong illumination all granulating surfaces are then coagu-

lated as in tonsillar remnants. This coagulation is repeated once a week; in the interim the area is kept clean with sprays and irrigations. Some contraction will take place, but there is usually enough of an opening for sufficient aeration and drainage.

In removing a portion of the atresia, whether osseous or membranous, it is best not to go too far laterally as there is some danger of injury to the nerves and blood vessels coming through the ptergopalatine and posterior palatine canals.

Atresia of the Nasopharynx

This condition is not common. There is a scarcity of material in the literature about it. Wright[12] and Smith collected about 69 cases and advocated the use of monochloracetic acid on the raw surface after division of the atresia. They concluded that the congenital type is exceedingly rare.

Symptoms depend upon the extent of the atresia, which is seldom complete. There is usually difficulty in nasal breathing. Obstruction of the eustachian tubes gradually causes loss of hearing. The voice develops a pronounced nasal tone, and interference with proper drainage from the sinuses leads to profuse, foul, greenish purulent secretions in the nose, which are most annoying. There is usually some loss of smell and taste associated with this condition.

It is the acquired form that presents the problem of retaining patency. The outcome depends upon two factors: the nature of the pathology and the extent of the involvement.

Except when the acquired atresia is of luetic origin, the prognosis for the repair is good. In syphilis, tissue has a tendency to break down and cause destruction of other tissue. When arrested, this tendency yields to marked cicatrization with contraction. Non-luetic scar tissue is free from this undesirable characteristic.

MacKenty,[13] in 1927, came forward with an ingenious surgical method which was the first to prove efficacious in this type of case. His operation was based on the principle of Nichols[14] that the defect has its origin in a tendency of wounds to heal from their periphery toward the center. For MacKenty's flap operation to be successful, it

is essential that the mucous membrane on the posterior pharyngeal wall below the normal line of the velum palati should not be entirely destroyed. The condition is almost hopeless if there is nothing but scar tissue; if the atresia above is extensive and the whole pharynx is contracted to the center; and especially if syphilis is the cause. A good result may be expected if the atresia is shallow, if the mucous membrane below it is partly preserved, if the pharynx has a fairly wide and normal look and if the condition is traumatic or due to a simple inflammation. Dilatation should be carried out after the operation to such an extent and for such time as seems indicated.

McIndoe[15] bores a hole between the adherent palate and the posterior pharyngeal wall from the pharynx into the nasal cavity. He then places a mould of dental stent covered with a Thiersch graft between these two separated raw surfaces. The mould is retained by a double silk thread tied around the columella and retained in place for at least two or three months. In this fashion he reports that an excellent passage is created. Drainage of the nasal cavity and sinuses is attended by remarkable improvement in the patient's general health.

Many plastic operations such as incision with dilatation or cauterization have been advanced to correct this difficult problem. Some successful cases have been reported with the use of diathermy. Others have reported using the flaps from the mucous membrane of the adjacent cheeks. These, like others, fell by the wayside.

Figi[16] reported 18 cases of stenosis of the nasopharynx from the Mayo Clinic. Like MacKenty he followed the principle of Nichols. Nichols[14] treated 13 cases successfully by inserting a seton at the base of the web until cicatrization took place, and then incising to this point he inserted a silk suture through the small nasopharyngeal opening well into the lateral extent of the region of scarring. This suture was tied and left in place until a cicatrized tract developed. The posterior border of the soft palate was then freed from its attachment to the pharyngeal wall out to this point.

In Figi's last six cases, which were successful, he used the same technique with some variations. He added a small lead weight,

which was clamped on over the ends of the suture, and allowed the suture to cut through by itself. This usually required one to two weeks. When this happened, it was replaced by another, taking a wider lateral bite. Subsequent dilatation with rubber-tipped Kelly forceps was employed in most cases.

Recently the writer employed a more simplified technique, not original, which proved successful. The scarred soft palate was gently released from its attachment to the posterior pharyngeal wall by a transverse incision. Palatal scarred tissue was removed until a large opening was made. A very large but short soft rubber tube with hinges on both sides was introduced via the mouth. The hinges rested on the posterior surface of the lateral walls of the soft palate. The upper end of the tube faced the choana, and the lower end was seen slightly coming through the oropharynx. In this fashion the tube was well immobilized and unable of its own account to fall either into the mouth or forward into the nasal chambers.

The tube was kept in that position until all the margins were completely epithelialized. It can be easily retained for several months without causing any undue damage. There are some discomforts for the first few days until the patient becomes accustomed to it.

Soft rubber tubes do not produce an irritation as do the hard ones and perhaps because of this prove to be most useful in these cases.

When surgery is completed, these patients should receive vocal training. The palatal muscles are essential for phonation, and having been unable to function because of the atresia, they require re-education after operation.

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A REVIEW OF RECONSTRUCTIVE SURGERY OF THE FACE

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Nose

Interest in the correction of nasal deformities has been stimulated by the recent use of preserved cartilage transplants. O'Connor[62] and Pierce[63] collect such cartilage under sterile and unsterile conditions, strip it of perichondrium and store it in 1:1,000 aqueous merthiolate in a refrigerator. The incidence of infections in their transplants has been low, but all of them have occurred in noses. Because of this they advocate making intranasal or columellar drainage wounds and irrigating the graft bed with a merthiolate-saline solution. Partial or complete absorption of the transplants in their series was only an occasional finding and they believe that the preserved cartilage curls less than fresh. Brown[8] states, however, that absorption takes place to some extent in all instances and complete loss may occur by a gradual process without visible reaction over a period of several months. This process is not always uniform and the transplant may appear actually scalloped. He points out that the experimental implantation of pieces in animals or in the abdominal wall of patients is not comparable to the clinical use because these beds are better than those about the nose and face, where the material is usually needed. He finds that the preserved implants do not withstand infection well, but they have healed in satisfactorily following drainage from the wound in some instances. Childrey[20] advises placing sulfathiazole in the wounds with the transplants and giving it orally to prevent infections. Peer[69] obtained microscopic sections of six pieces of preserved cartilage which had been implanted from nine and one-half months to two years and found that all of them showed progressive invasion by fibrous tissue and

partial absorption. Eight segments of autocartilage studied similarly showed no invasion nor absorption. Two autografts buried four and one-half years and six years appeared as living cartilage. After having used preserved cartilages since 1928, Brown's conclusion is that it should be used only as a second choice substitution when, for some reason, fresh cartilage is not advisable (see Figs. 1 and 2).

FIG. 1. Diagram of L-shaped cartilage transplant. (a) Above. Side view of single piece of cartilage to restore nasal contour with support at the nasal spine and above. This type can be put in luetic noses with only a small amount of tissue left in the columella. If the whole cartilage is lost but the mucosa remains, even a larger sheet may be used practically to replace the septum. The upper end is always placed under the periosteum if possible, and this applies to all regions; if only a small pocket of periosteum can be prepared, the best possible support is then obtained. The large piece is best obtained by cutting it out of an angle or where two cartilages are united. (b) Top view, showing breadth above and thinning below to avoid widening of the tip and columella. If necessary to gain lateral bulk, wide side wings may be left on or extra pieces put in. Both views are diagrammatic. The general shape is cut out and then trimmed down to pattern.

Wolfe[83] prefers ivory to cartilage, stating that the latter often produces an abnormal midline ridge due to absorption. Cohen[24] prefers a mixed cantilever type of graft, using cartilage for the septal and columellar portion, and bone for the dorsum. Brown[8] prefers an L-shaped piece of cartilage which is cut in one piece, obtaining its support below at the nasal spine, above at the glabella, and along the septum if any is present. Young[84] advocates a cartilage graft shaped like a tent; the columellar strut is cut from across the end and left attached by a hinge of perichondrium, and similar lateral struts are turned down from either side. Harbert[39] uses ear cartilage as a simple dorsal implant, leaving the anterior perichondrium in the ear to regenerate. Warping is said to be less than

FIG. 2. (a) Left. Deformity following autogenous cartilage transplant (done elsewhere) with calcification and distortion of the cartilage, rendering it useless. (b) Result of preserved cartilage transplant. Complete mobilization of the lateral bony walls was necessary for narrowing after the distorted cartilage was removed; through and through wires were put in for fixation. As it is often best not to combine an extensive osteoplastic with a fresh cartilage transplant, a preserved cartilage was used as a temporary subcutaneous prosthesis. It was healed promptly, however, and is in good condition more than two years later.

in that obtained from a rib. Sarnoff[74] illustrates a case with a depression between the bony nose and the tip, following a submucous resection. This was filled by rotating the upper lateral cartilages into the defect, after narrowing the bones. Cinelli[21] illustrates two luetic saddle noses which were repaired by a very extensive operation through a combination of intraoral, intranasal and external skin incisions, cutting the columella loose from the lips and inserting a two-piece rib graft.

A. M. Brown[7] describes the "artistic anatomy" of the nose, noting that the congenital humped nose presents a hypertrophy of the whole nose, including the septum and external cartilages, while the traumatic nose usually presents only humping and widening of the bony portion.

Maliniac[53] discusses the prevention and treatment of late sequelae in corrective rhinoplasty. Though Joseph dressed his rhinoplasties with only a little adhesive and gauze, Aufricht[1] found that occa-

sional hematomas followed this, and he has been using a pressure dressing for many years. The details of his method of using dental molding compound for this purpose are well described and he stresses the necessity of evacuating all blood, sawdust and cartilage debris from the interstices of the nose before applying any splint. Pearlman[68] introduces a short metal nasal splint with slits cut on each side for easier bending, a combination chisel and periosteal elevator, and a four-bladed thumb forceps for introducing cartilage transplants.

Kopp[50] states that all surgical procedures for the relief of atrophic rhinitis depend upon decreasing the width of the nasal chambers. He thinks that this disease does not contra-indicate an osteoplastic operation and is often helped by it.

Ivanissevich and Ferrari[41] illustrate the "Argentine method" of replacing the tip of the nose with a jump flap of the full thickness of the ear, using the thumb as a vehicle. Straith[76] uses an ordinary tubed vertical neck flap for this purpose but transposes the upper end as the skin from behind the ear more nearly matches that of the nasal tip.

Brown[13] has written a rather extensive review of the procedures used by him in the correction of various types of nasal deformity. Included are operations for reduction in size, deviations of the nose, fractures, lacerations of the soft parts, saddle nose, replacement of the skin covering, total and partial nasal restorations, retrusion, nasal deformities associated with cleft lip, rhinophyma, and the treatment of hemangiomas about the nose.

Cleft Palate and Lip

For complete single clefts, Ivy[42] prefers to close the anterior palate by a first stage Veau operation at the time of the lip closure, usually between the ages of 6 weeks and 3 months. The posterior portion is closed by the method of Axhausen not before the age of 2½-3 years. At this operation the lateral flaps are raised as for a von Langenbeck procedure but both major palatine arteries are cut and tied. The cleft edges of the palate are divided by splitting and

not paring, and the nasal mucosa is elevated from the bone in such a manner that its continuity back over the soft palate is maintained. The palate is then closed in three layers: nasal mucosa, muscle and oral mucosa. Median clefts of the soft palate are likewise closed by the Axhausen procedure. For complete double clefts, he does a first stage Veau operation on one side, closing that side of the lip at the same time. The other side of the lip and palate are done a few weeks later and the remainder of the cleft is closed at 2½-3 years by the same Axhausen technique. For velopharyngeal insufficiency he advocates Dorrance's push-back or Brown's elongation operation.

Kazanjian[43] also prefers a two-stage operation for complete single palate clefts, closing the anterior portion first and the soft palate a few months later. Smith and Johnson[75] prefer Dorrance's method of closure for ordinary clefts and his push-back procedure for congenitally short palates, with some modifications of suture material and technique.

Brenizer[5, 6] uses wide bands of transplanted fascia placed across the nasal surface to take the tension off the suture line and to act as a scaffolding and support for the palate. He is unable to visualize the bands after operation but believes that they persist. Fascial or catgut bands are also utilized in closure of the lip, especially in double clefts. He sections the neck of the premaxilla and slides it back "like a drawer," after which the bands are sutured underneath the mucoperiosteum of the premaxilla and the alveolus on either side.

Brown[9] has found it possible to do double elongations of partially cleft palates to gain maximum length and at the same time preserve the levator and sphincter actions. The procedure is used in palates in which there is so little tissue that one elongation will not give sufficient length for total nasopharyngeal closure. His regular elongation with preservation of the arteries is done at the first stage. At the second operation, the originally elongated portion is split from before backward and from side to side, care being taken not to break through into the nose. The arteries are sacrificed at this

time and a second elongation done. The cleft may be closed at either stage as desired. As a corollary to this procedure, he also found that elongations could be done in totally cleft palates which have been satisfactorily closed and in which additional length is desirable. He emphasizes that for best speech the palate must not only be of sufficient length, but the velum must be soft and pliable and its motor mechanism intact. In any procedure in which the posterior pillars are sutured together behind the uvula, or in which a posterior pharyngeal flap is sutured to the velum, a tight scar band is placed in the region where the most movement is essential.

For partial palate clefts, Kilner[48] does a Wardill pharyngoplasty followed by a V-Y procedure behind the incisor teeth (incision of Ganzer) to lengthen the palate. For total single and double clefts of the lip and palate he uses modifications of the Veau procedures.

In primary lip repairs, McIndoe[57] completely mobilizes the alar cartilage on the cleft side to correct the nostril deformity. Incisions are made on the inside above and below the cartilage and it is freed from the skin as a "bucket handle flap." This allows the cartilage to spring forward and take its proper place in the new skin mold. In secondary repairs, the same mobilization is followed by any necessary trimming and suture fixation to properly shape the nostril. Humby[40] fills out the depression of the nasal tip on the cleft side by swinging a flap of the normal alar cartilage over in front of the dome of the cartilage on the cleft side. Sometimes the major portion of the horizontal crus of the normal cartilage is used in the flap, but he has not found the collapse of the tip on the sound side to be very noticeable. Owens[64] reviews the history of operations for cleft lip and palate, stating that he prefers a modified Mirault procedure for single lips.

Protruding Ears

Davis and Kitlowski[29] call attention to the lack of a visible antihelix in many prominent ears and believe that this ridge should be reconstructed as the ear is set back. If the ear is held back against the scalp, the antihelix becomes visible and it is marked by green

puncture marks along the ridge extending completely through the ear and into the postaural skin of the scalp. An ellipse of skin is thus demarcated, half on the back of the ear and half on the scalp, and excised. The cartilage is incised along the line of these dots and a narrow vertical ellipse taken out. The remaining proximal and distal pieces of cartilage are then sutured together back-to-back with their raw edges pointing forward to form the ridge of the new antihelix and the skin is closed. New and Erich[59] do a similar operation but use mattress sutures put in on the anterior surface of the ear to hold the new antihelix forward. The amount of tension on these sutures controls the prominence of the new ridge. MacCollum[51] outlines three procedures for the correction of these ear deformities. His second method is essentially the above operation, except no skin is excised. In his first method, an ellipse of skin is excised and the cartilage is incised along the puncture marks. A narrow crescent of cartilage is then excised from the outer or distal portion and the cartilages are repositioned with the cut edge of the proximal piece placed anterior to the outer cartilage. Thus the cut edge of the proximal cartilage alone forms the new antihelix. In the third method, a narrower ellipse of skin is removed and a pear-shaped portion of cartilage is excised, the widest portion being at the base of the concha. The cartilages are then approximated back-to-back. In any operation in which skin is excised, the cartilages are sutured back to the galea before skin closure.

Rigg and Waldapfel[72] have devised a procedure for the correction of drooping or "dog" ear, a condition in which the upper portion of the ear is turned down and outward. An ellipse of skin is excised from the back of the upper ear and adjacent scalp. A rectangular flap of ear cartilage is then turned backward and inserted beneath the periosteum of the adjacent skull and the skin is closed.

Reconstruction of Ears

Padgett[66] illustrates some total reconstructions, using rib cartilage for the framework, a flap for the back and helix, and a free graft for the raw scalp surface. He uses a fairly wide vertical neck flap

with the distal portion split into a small tubed flap for the helix and a large flat portion for the back of the new ear. He prefers to wait until the individual has attained his full growth before operating, as the growth potential of a reconstructed ear is not certain. Attempts to reconstruct the canal are not thought practical. Kirkham[49] introduces an interesting variation, using a cadaver ear cartilage as a framework. As the cadaver ear cartilage behaves somewhat as a foreign body and may become loose from the surrounding structures, he makes holes through the transplant so that granulations may penetrate and fix its position. O'Connor and Pierce[63] use preserved rib cartilage for the framework.

Facial Paralysis

Cleveland[23] reviews the rather voluminous literature between 1932 and 1938 on the treatment of facial paralysis. Direct nerve suture and free nerve transplants, as introduced by Ballance and Duel, are established procedures when applicable. The trend seems to be away from preparing the grafts by allowing Wallerian degeneration to occur. Bentley (quoted by Tickle[77]) found that an equal amount of time was required for the return of function with degenerated and fresh grafts. He believes that very few neurones grow down through the tubules of the graft, most of them passing along the outside of the sheath. Bunnell and Boyes,[19] working on cats, also found that prepared grafts had no advantage over fresh ones. Sections showed some neurones growing through the graft, but most of them near the periphery. They explain this on a nutritional basis and advise using cable grafts of multiple small strands to permit better contact of most of the fibres with the surrounding lymph.

Interest in hypoglossal-facial anastomoses was somewhat renewed by an article published by Coleman.[25] Two excellent results are illustrated and the indications for and details of the operation are described. He has been impressed with the failure of the nerve-grafting and suture operations to restore emotional expressions or to prevent mass movements of the face, and notes that it is im-

possible to correctly align the proximal and distal ends of the fibres supplying the individual muscle groups; however, he uses the anastomosis chiefly for cases in which there has been intracranial damage to the nerve. The hypoglossal nerve is usually preferred, but in loquacious patients it may be better to use the spinal accessory. If there is any residual paralysis or incomplete

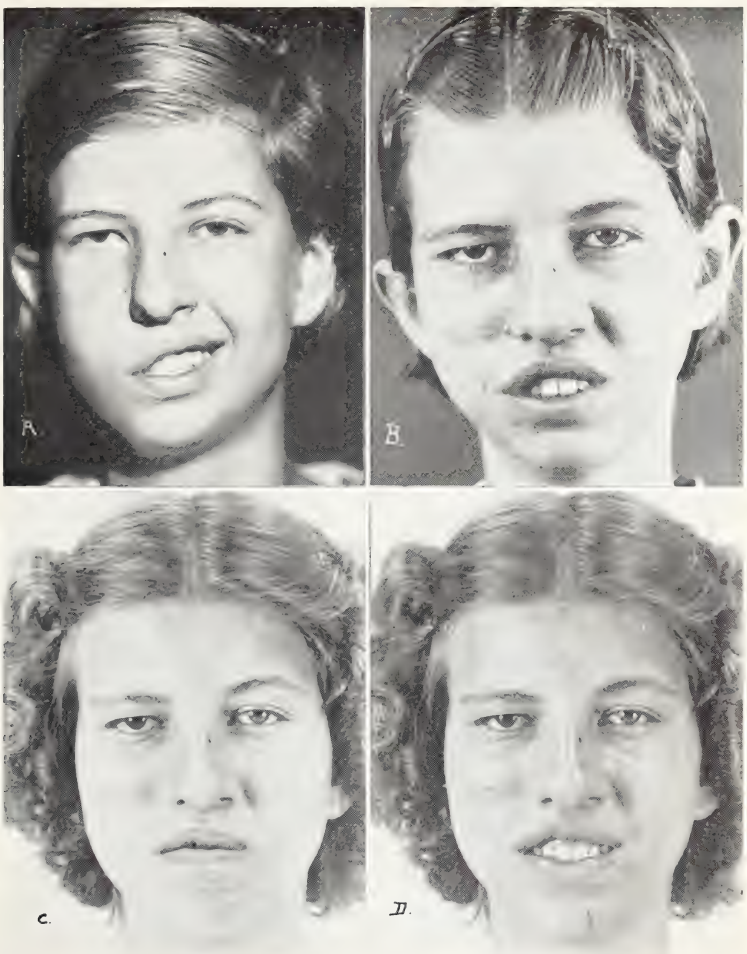

FIG. 3. (a) Complete facial paralysis—congenital. (b) Result of the described operation showing motor power of the (Vth nerve) temporal muscle elevating the lip in a slight smile to give some degree of emotional expression. (c, d) Later photographs to show persistence of result and also improvement in control of the face and in emotional expression.

recovery of important muscle groups, Brown's operation[10] may be used as a supplementary procedure.

For those cases in which nerve anastomosis, suture or transplant is not applicable, various plastic procedures have been devised. Sheehan, Halle and others[23] have attached muscle and muscle-nerve pedicle flaps from the temporal and masseter muscles to the corner of the mouth. Sheehan has noted that the bulk of the flap is sometimes disfiguring, and makes a groove in the zygoma to accommodate it when this is the case. Brunner[18] uses a masseter muscle flap, doing all of the operating through the inside of the mouth. He believes that filaments of the Vth nerve grow out of the masseter flap and innervate the surrounding muscles of the face.

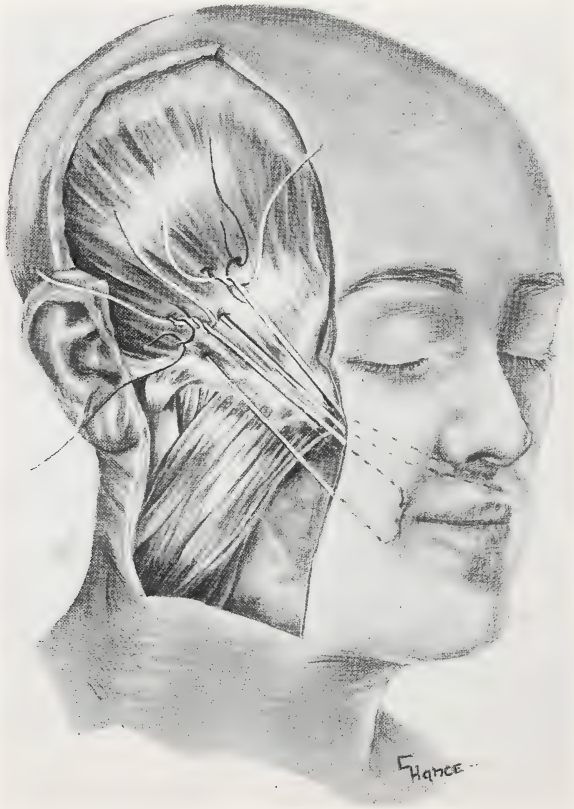

FIG. 4. Diagram of the free fascial loops' course through the face and fixation in the temporal muscle.

Brown[10] obtains balance and movement of the paralyzed face by means of transplanted fascial loops connecting the lower face with the most mobile portion of the temporalis muscle. Long strips of autogenous fascia are introduced through an incision in the hair-bearing temporal region. One strip is passed subcutaneously down to the philtrum or the middle of the upper lip and then back at a slightly lower level to form a loop. Another similar loop is passed down to the corner of the mouth and the lateral portion of the lower lip. Both loops are then anchored to the tendon of the temporalis muscle just above the coronoid and any excess skin is excised before the temporal wound is closed. After any swelling and soreness has subsided, the conscious act of setting the closing muscles of the jaw produces some degree of emotional expression in that side of the face, including a slight smile and the production of a nasolabial fold (see Figs. 3, 4 and 5). The patient is trained in limiting the degree of movement on the sound side and in coordinating the movements of the two sides. After a preliminary period, this should become an involuntary or subconscious function. Some improvement in any sagging of the lower lid is obtained by the above procedure. If the lid needs further support, this may be obtained by passing another strip of fascia from the temporal region through the lid to the opposite frontalis. No attempt is made to obtain Vth nerve motion for the lids as this would be too gross and too conscious. For any apparent exophthalmos present, the palpebral fissure can be narrowed by a small external canthoplasty.

Eye

So many substances have been advocated to replace conjunctival loss that it is evident that all of them leave much to be desired. Clay and Baird[22] have been using grafts from the prepuce and labia minora and illustrate two such cases. These grafts have the appearance of conjunctiva and do not desquamate. Fetal membranes are used for this purpose by de Rötth.[31] The membranes were obtained by Caesarean section and implanted from one to 15 hours later.

The transplants were used in six cases for symblepharon and for lining a socket in two instances. The chorionic surface is placed next to the wound, with amnion forming the free surface. The grafts took in each instance and for three weeks they showed no change. In the next weeks the grafts shrunk and 10 weeks after operation they seemed to have disappeared, but there was always more fornix left than before operation. Blair and Byars[4] use free

FIG. 5 (a) Complete ptosis of the upper lid from a IIIrd nerve lesion, and paralysis of the frontalis (VIIth nerve) muscle from the local scar. (b and c) Elevation and some degree of emotional expression in the lid by attachment of lid to the forehead with fascia, and by a second loop of fascia from the temporal fascia through the tarsus to the opposite functioning frontalis.

skin grafts. The scar is dissected out and the graft is inserted over a wet cotton or paraffin mold and the lids are closed with sutures. Some corneal irritation, and even transient ulceration, has been encountered, but this is believed due to technical errors rather than to any fault of the method.

For paralysis of the lower lid resulting from interruption of the nerve supply, Blair and Byars[4] have used autogenous fascial strips. Sometimes the strip is anchored on either side above in the frontalis muscle, being put through a lid as a hammock. In other cases a circumferential strip has been used through both lids and anchored above the eyebrow or in the temporal region. These have been combined with canthoplasties when indicated to narrow the palpebral fissure. For paralysis of the lower lid resulting from loss of substance or scarring in the neighborhood, a small forehead skin flap has been used as a hammock. Rosenburg[73] describes the treatment of ptosis by means of a fascial sling passed through the upper lid

and anchored in the frontalis, combined with an elliptical excision of skin from the upper lid. The treatment of ptosis and of the eyelid deformities associated with facial paralysis was also included in Brown's[10] paper on the latter subject (see Fig. 5).

Facial Repairs

Kazanjian and Converse[43] prefer osteoperiosteal grafts from the tibia for repair of defects of the frontal bone. The grafts are chiseled out in long strips and multiple fractures are made in them if necessary to get the proper curvature. They prefer an incision above or below the eyebrow if possible, as a hairless brow scar is often quite evident. New and Dix[58] use autogenous rib cartilage routinely for this purpose. Often it is necessary to suture several pieces together with fine silk to fill a large defect. At times the transplants are fixed to the frontal bone with small pieces of stainless steel surgical needles used as tacks. For small defects, overcorrection with a pad of fascia lata may suffice. They have tried free fat transplants but are not enthusiastic about them. Peer[70] also prefers autogenous cartilage, but has used preserved in some instances when the former was not available in sufficient quantity. Dermal grafts are used for shallow depressions.

Figi[34] has outlined some of the methods useful for the repair of defects resulting from the removal of extensive antral tumors. Cheek perforations are closed with forehead or chest flaps, while any bony loss about the orbital border is repaired with cartilage or bone transplants. Any elevation of the upper lip is corrected by freeing the scarred attachment of the lip from the maxilla and skin grafting the inner surface. Displacement of the meatus of the parotid duct in one instance resulted in drainage of saliva into the nose and this required transplantation of the duct to the mouth.

New and Erich[60] have published a very clear and complete description of the various local flaps and transpositions that may be used for the closure of small lip defects. The repair of large defects with forehead flaps, tubed neck flaps or flaps from a distance is

similarly well illustrated. Daland[26] excises large lip lesions in a rectangular manner and closes the defect by sliding lateral flaps in together. Wide undermining is necessary, together with lateral cuts extending from both lower angles of the rectangle. The orbicularis is separated from the other facial muscles at the angle of the mouth to permit satisfactory rotation of the upper lip down into the lower lip on each side. The procedure results in a rather small mouth opening in some instances.

Facial Injuries

The importance of complete diagnosis and early treatment is emphasized by most recent writers and is the subject of a paper by Foster.[35] Nearly everyone agrees that all dirt and oil should be scrubbed out of such wounds, perfect hemostasis obtained, and meticulous closure of the soft parts done. Brown and McDowell[11, 17] believe that replacement of any fractured bones at the time of primary repair is a keynote and describe the common fractures and their treatment. Conservative debridement is advocated so that parts of features will not be needlessly sacrificed. Whitham[82] illustrates fractures of the upper jaw, nose and zygoma, together with methods of late restoration with flaps and transplants. Bellinger[3] describes the treatment of jaw fractures with interdental wiring and with elastic traction, stating that instead of draining all of them which are compounded into the mouth, he prefers to wait and drain only those in which abscesses occur. E. D. D. Davis[27] writes that "a fracture of the mandible will not unite if the teeth on each side of the line of fracture are not extracted." Brown[12] places a small dependent drain up to all fractures which are compounded into a tooth socket and does not extract the tooth in the fracture line early even if it is somewhat loose. This is believed to be of especial importance in molar fractures in which the tooth may prevent the tendency to upward displacement of the posterior fragment. Von Wedel[79] gives a good description of the care of the bones and soft parts in facial injuries.

Mandibular Operations

For replacement of resected portions of the jaw, Kazanjian[44] uses osteoperiosteal grafts from the tibia. The jaw should be immobilized in occlusion from the time of the resection until the transplant is done. In dealing with tumors of the ramus, the head and neck of the condyle should be left in if possible.

For retrusion of the jaw, he extracts the second molar tooth on each side and does an intraoral L-shaped osteotomy of the body in that region and slides it forward. The jaw is then held forward with interdental wires and an external appliance anchored to the forehead and upper incisor teeth. This procedure may be supplemented later by a bone or cartilage transplant in front of the chin. For prognathism, he does a horizontal section of the ramus and slides the jaw back unless it is associated with an open bite, in which case he does an oblique osteotomy in the body near the angle.

New and Erich[61] discuss the retruded chin, including etiological processes, varieties and the types of treatment. The corrective procedures, in general, follow six plans: 1. various types of osteotomy through the horizontal or ascending rami to lengthen or advance the mandible; 2. osteotomy through the horizontal rami associated with the use of bone grafts to lengthen the mandible; 3. cartilage implants inserted behind the head of the condyles for advancement of the mandible; 4. cartilage, bone, ivory and celluloid implants for building up the chin to normal contour; 5. prosthetic appliances requiring the use of intraoral skin grafts for restoration of normal chin contour; and 6. orthodontic methods. They point out that in those cases in which the chin has been built out with cartilage transplants, the lower lip may remain retruded. This latter deformity is corrected by incising the fornix between the lip and alveolus, widening the sulcus and skin-grafting the resultant raw area. The lip is then maintained in its new forward position by wearing a prosthesis in the sulcus. Weisengreen[81] also reviews the operations for micrognathia and macrognathia, together with the methods of direct fixation of the fractured mandible.

For temporomandibular ankylosis, Kazanjian[45] removes a com-

plete section of bone from the bottom of the sigmoid notch backward and downward. A sufficient amount of fascia to obliterate the dead space is then inserted between the ends. Giangrasso[36] does a linear osteotomy at the base of the neck of the condyle and interposes a piece of rubber glove between the fragments.

Miscellaneous

Mason, *et al.*,[55] illustrate a case of congenital lip pits in which there were two large oval sulci, one placed horizontally on either side of the midline. It is noted that during the late prenatal and early postnatal life, the glabrous and villous portions of the lip are ordinarily separated by a sulcus. These pits apparently represented persistence and deepening of portions of this sulcus; *i.e.*, a tendency to reversion to a double lower lip. They were treated by oval excision and advancing mucosa up out of the fornix to suture to the skin. Baxter[2] describes some similar lesions which he calls "congenital fistulas" of the lower lip. He has found that they may be too small to admit a fine probe, or may be as much as 0.5 cm. in diameter, and not infrequently mucous glands open directly into them. He advocates destroying the smaller ones by electrocoagulation and excising them if large.

Brown and Byars[14] report four- and seven-year cures of malignant melanomas which had metastasized to lymph glands. They believe that these lesions should not be regarded as entirely hopeless but should be treated by complete local excision and radical excision of the regional nodes. It was observed that many of the fatal lesions had been previously subjected to multiple electrodesiccations. They prefer to remove moles by cutting them out with the actual cautery, going down into the subcutaneous fat. In deciding which moles to remove, it is believed that all which are subjected to chronic irritation, or which show evidence of growth, increase in vascularity, change of color, repeated infection or ulceration should be excised. The smooth, coal-black nevi should likewise be removed. Maliniac[52] treats small nevi by desiccation or by trichloracetic acid, except the flat ones, which are usually excised. For the larger ones, he prefers

single- or multiple-stage excision, followed by rotating in adjacent skin flaps, or free skin grafting.

Brown and Byars[15] note that hemangiomata may be found in all degrees of severity from small, bluish-red blotches and port wine stains to large, venous engorgements and areas filled with bright red arterial blood. The blotches and deeper stains and even the large venous channels are often congenital and might be considered as local anomalies rather than tumors, but the bright red arterial type is apt to exhibit definite new growth characteristics. In infants and children, consideration of the "strawberry" or arterial type is most important because of their tendency to spread, and when present on the face, to destroy features. Surgical excision or cautery destruction is the best treatment when their size and location are such that the treatment will not deform features or other contraindications are not present. Surface radiation may be used when the involvement is not deep and where applications can be made satisfactorily. In bulky lesions, where excision is not applicable, interstitial implantation of gold radon seeds is the method of choice. Ward and Covington[80] advocate surface radiation for most of the capillary and cavernous types. In the cavernous types, it is usually necessary to follow this up with interstitial electrocoagulation. It is noted that irradiation gives poor results in port wine stains. Solid carbon dioxide is used by them for very small lesions, residual patches, and areas about the eyelids and scrotum.

Gillies[37] describes the technique and uses of his well known tubed pedicle flap, illustrating the most common donor and recipient sites. He utilizes them for a wide variety of repairs, recommending them especially for restoration of the avulsed scalp, massive face reconstruction, large cheek defects, or when restoration of contour is necessary, total loss of lips and chin, the contracted neck, or the nose if a forehead flap is not used. Maltz[54] has experienced some difficulty in getting the flaps to lie flat after untubing and therefore prefers to tube them in a reverse manner, with the raw surface on the outside. "The interrupted sutures of silk forming the tube can be

tied in such manner as to prevent union of opposing edges of the wound. In such instances, the stitches eventually pull through and the tube unrolls by itself by the time it has to be transplanted."

In England, Rank[71] has been using Thiersch skin grafts to prevent contractures in burns. The percentage of loss due to infection is perhaps greater than that ordinarily seen in this country, but the results are well worth while. Padgett[65] has introduced a new instrument for cutting partial thickness skin grafts. It consists of a metal drum with an attached sliding knife blade which can be set at various distances apart. The drum is made adherent to the skin with rubber cement, thus forming a skin diaphragm for the knife to cut on. The drum surface measures 8 x 4 inches, so a split graft of 32 square inches or smaller can be obtained with it.

J. Staige Davis[28] writes of the value of small deep grafts for repairing surface defects and states that it has been possible to transfer them successfully after refrigeration for as long as five weeks. He prefers the anterior surface of the thigh for a donor area as the skin is thin and of about the correct tension. He believes the appearance to be less satisfactory than that of split grafts, but they are usually used in unexposed areas. The small deep grafts are thought to take in many instances on surfaces on which no larger graft could.

Uihlein[78] states that the cutis or dermal graft is being used increasingly, both in the repair of hernias and for restoring contour in plastic work. Eitel, using the Warburg technique, demonstrated that the dermis is more active and lives longer than fascia. Dean[30] describes this graft under the name "dermigraft" and apparently has used it for surface covering. A Thiersch graft is cut from the thigh and left attached at one end "to retain the blood supply intact,' 'after which the dermal graft is removed and transplanted. The Thiersch graft is then sutured back down in place.

McCarroll[56] has noted that sensation returns simultaneously throughout free skin grafts, averaging 45 days in split and 60 days in full thickness grafts. In flaps, however, the sensation returns

first near the pedicle, then near the area first attached, returning throughout on an average of 285 days.

Several interesting treatments of avulsed skin flaps have been recently proposed. Farmer[33] and Keyes[47] advocate careful cleansing, removal of all fat from the back, and replacement as a free full thickness graft. The "take" has not been perfect in the recorded cases but has been of a sufficient amount to make the procedure worth while in selected cases. Douglas[32] cuts pinch grafts from the avulsed skin flap and implants them.

The details of preoperative and postoperative care in reconstructive surgery are discussed by Brown, *et al.*[16] Among other things, the use of pressure dressings on all grafts, flaps, transplants and also on most ordinary wounds in recommended. It is believed that this minimizes the occurrence of hematomas and edema and, thereby, infection. The external bandage produces the pressure, but it can be transmitted to the wound by various materials. Marine sponges have been used for some time but have recently been largely supplanted by soft cotton mechanic's waste. This material is readily obtainable, inexpensive and packs nicely down into small crevices and folds to transmit an even pressure to an uneven surface.

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FREE SKIN GRAFTS VERSUS FLAPS
IN SURFACE DEFECTS OF FACE AND NECK

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The purpose of this article is to review the factors which determine the selection of a procedure of choice for resurfacing skin defects on the face and neck.

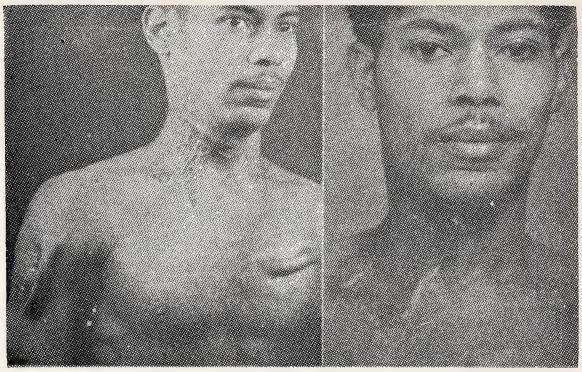
It is agreed that early and permanent covering of a cutaneous defect is required for good health, function and comfort. The difficulty is to choose the most suitable method for each individual case. What are the reasons which govern the choice between free grafts and flaps for the restitution of a given part?

This discussion is limited to the face and neck because of the special requirements which must be taken into account in these regions. Thus, while extensive scars on concealed body areas can often be left unattended, even limited skin losses on the face must be resurfaced, both for appearance sake and because of the danger of scar formation around the facial cavities with consequent distortion. The color and texture of the skin graft are also problems of great importance here.

In planning the reconstruction, determination of the real tissue loss is the first step. Accuracy in selecting and outlining the required skin will depend on the precision with which the amount of loss is defined.

In addition to technical considerations, the patient's mental attitude, financial status, sex and age must guide the choice of procedure. We must treat the patient first and the deformity second.

Mental Attitude—Guarded opportunism is an important consideration in reparative surgery; and in this the patient's psychological outlook must play a part. Often the surgeon is called upon to decide whether certain risks should be taken in order to attain



A B

FIG. 1. A, scarring of neck following skin loss fom a virulent streptococcic infection. The tube flaps on arm and chest outlined elsewhere for the repair of the neck defect were inadequate, too small and improperly placed. The use of a tube flap is unjustified in this case because of the number of operative stages which would be required, B, following excision of the scarred area the skin defect was covered by thick split graft, 0.024 of an inch in thickness. This type of graft generally provides a covering of acceptable color and a satisfactory neck contour. When some retraction of the graft takes place it is indicated to add a skin graft of greater thickness, a free full thickness graft preferably. A good take of these grafts necessitates a thorough immobolization under appropriate pressure.

A B

FIG. 2. A, radiodermatitis of neck and lower cheeks in woman of forty, with atrophy of skin and patchy pigmentation, following prolonged *x*-ray irradiation for removal of hair. The skin is leathery in spots with cracks tending to ulceration. The danger of malignant degeneration is sufficiently great to favor excision. B, appearance of the skin graft two months after surgery. Excision of the involved area was done along the mandibular border in the concealed area of the neck. A free skin graft, 0.024 of an inch in thickness, taken from the abdomen, covered the defect. Free skin grafts in this area are difficult to immobilize and require particular attention to adequate pressure. Thorough immobilization requires inclusion of the head and chest into the dressing.

an ideal outcome, or whether an inferior procedure should be selected with less risk. The patient's attitude toward his deformity should influence this decision.

Financial Status—Financial consideration also play a part in the choice of procedure. The numerous, protracted surgical stages required in the use of flaps, for example, demand a measure of economic security in the patient.

Sex—The sex of the patient presents certain obvious considerations. For example flaps from the neck and upper chest, acceptable in men, are usually contraindicated in women who expose these regions to a greater degree. On the other hand, forehead flaps are more feasible for women than for men, because of the greater ease of concealment by the hair. Of course these are not absolute rules.

Age—The problem of age is important. Protracted procedures require stamina and co-operation. Neither is usually found in the very old or the very young patient. As a rule, therefore, the shorter and simpler skin-grafting procedures are employed in early and late life.

This does not mean that necessary reconstruction should be postponed in children. Delay in removing scars during the period of growth is often responsible for secondary deformities, due to maldevelopment of the bones of the facial skeleton and for serious psychic disturbances. *The profession as a whole is not yet sufficiently alive to the preventive value of reparative surgery in childhood.* Too many physicians still believe that an injured part should not be skin grafted until it is fully developed. As a rule the contrary is true. Unless the constituent elements of the injured part are in proper alignment, the underlying structures will suffer during the period of growth. Witness the many cases of maldevelopment of the nose, chin and orbit due to injury and scar pressure in childhood.

In addition to the foregoing considerations, the selection of a skin covering must be guided by the characteristics of the various free grafts and flaps now in use. There are three main groups (Table 1):

TABLE 1

Free Skin Grafts and Flaps

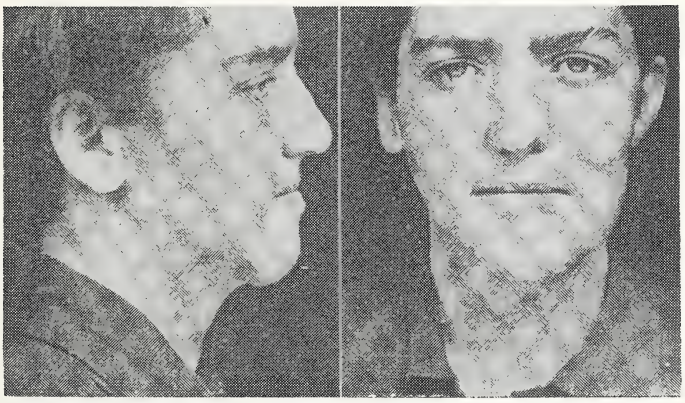
Type of Skin Graft or Flap	*Donor Area*	*Type of Defect*	*Surgical Procedure*	*End Result*
Thin (Thiersch) and thick split grafts Thickness: 0.008 to 0.026 inch	Abdomen; thigh and buttock; lateral chest; back	Granulating areas (thin grafts); mucous membrane loss in facial cavities; clean skin losses on face and neck (thick grafts)	Any sharp skin graft knife on stretched skin; Padgett's dermatome most indicated for cutting large sheets of skin	Color and texture improve with thickness; drawback: pigmentation; easy take.
Full thickness grafts	Retro-auricular and upper eyelid grafts; (best for limited losses on face); arm (inner aspect); supraclavicular; abdomen; hair-bearing: (eyebrows and scalp)	Loss of eyelid and eyebrow; limited losses on cheek and nose; neck: in excessive contraction of thinner grafts	Careful dissection with knife, eliminating all fat; thorough immobilization under proper tension and pressure.	Best cosmetically and functionally; more elaborate take.
Small deep grafts (Davis). Include part of derm.	Abdomen; lateral chest; upper thigh	Clean granulating wounds (except on exposed parts)	By raising skin with straight needle and slicing off top of cone	Poor cosmetically; easy take.
Derma — full skin without epithelium; for subcutaneous use only	Abdomen; lateral chest	Depressed areas of face—to restore contour	Prepared by shaving off epidermis with razor; used single or in few layers, with or without fat.	Absorbs about 50 per cent — corresponding overcorrection necessary; easy take.
Local flaps	Near skin loss: forehead, cheek, nose and neck	Loss on forehead, nose, cheeks, lips, chin	Outlined with proper length, width and thickness to assure adequate blood supply.	Excellent in color and texture: easy take.
Flaps from distance	Abdomen; lateral chest; upper chest; arm—inner aspect	Loss on nose, cheek and neck	Flaps transferred directly or through intermediate host-forearm; flap to be delayed if blood supply uncertain	Good in color and texture, although often too thick

1. Free Skin Grafts

The main advantage of free skin grafts over flaps is in the saving of time and expense in their application. However, their usefulness on face and neck must be appraised in the light of the end result.

A. Thin Grafts—Thin (Thiersch) grafts should not be used for permanent resurfacing of the face or neck because of their poor color and pronounced tendency to contract. They are pale, frequently pigmented, and, more often than not, wrinkle and contract

A B

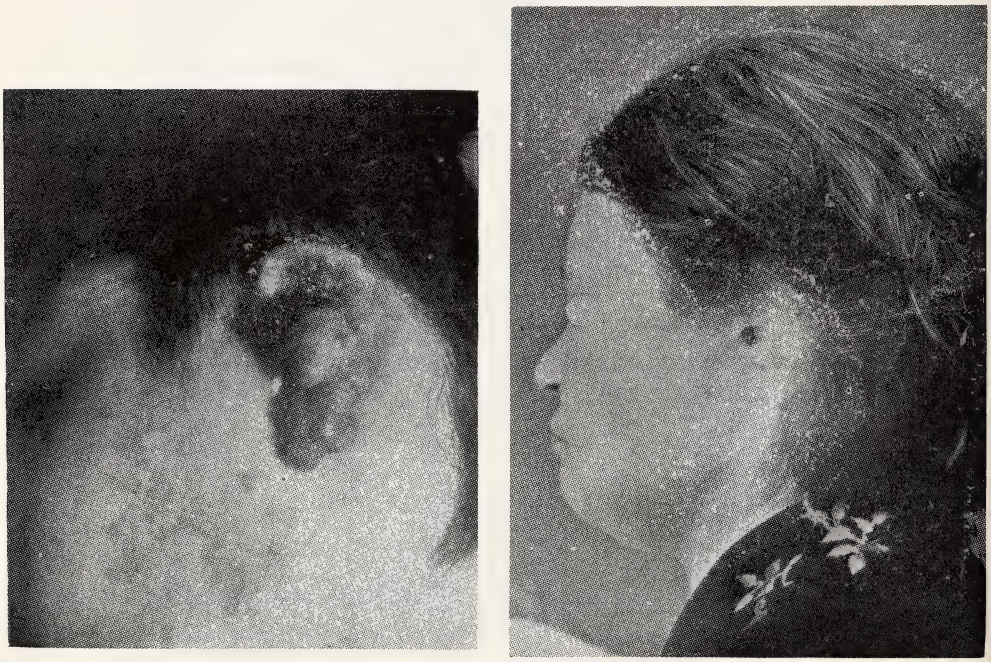


C

FIG. 3. A, burn scars of face and neck in a girl of seven, with obliteration of the neck contour and recession of chin, due to scar contracture. B, reconstruction at first consisted in the preparing of a tube flap from lateral chest which was transferred to the left cheek and chin; subcutaneous fat taken with the flap covered the depressed areas. C, the burn scars on the neck were not repaired until the age of eighteen, by a thick split graft (0.024 of an inch). The graft shown above is two months old and is abundantly pigmented. The contour of the neck, however, is satisfactory and is superior to the one which might have been obtained by a flap. The color of the graft is gradually improved and is approaching that of the surrounding area. Economic circumstances of this patient also favored a shorter procedure for the rebuilding of the neck.

when applied to areas without a solid base, such as cheeks and neck. Even as lining for the nasal cavities, sulcus of mouth, and orbit, the very thin graft should be discarded in favor of the thicker split graft (about 50 per cent of skin thickness) to prevent excessive contraction. I have had to re-operate cases of nasal atresia in which obliteration of the cavity recurred as a result of the use of too thin a graft. Where appearance or contracture is immaterial, the thinner grafts can of course be used.

Thin grafts have a definite use as a temporary wound covering to be replaced later by a thicker graft or flap. This early, temporary



A B

FIG. 4. A, lupus of ear and cheek of about thirty years' duration, with malignant degeneration of auricle, following prolonged treatment of various physical and chemical agents. B, auricle amputated, lupus area of cheek widely excised and covered by a *thick split graft.* There has been no recurrence of either lupus or malignancy since surgery was performed nine years ago. The use of a full thickness graft would provide a better color, but its use was contraindicated because of the presence of an active local lesion and the possibility of recurrence. Wide excision, followed by skin grafting, is the procedure of choice, in the treatment of lupus cases unaffected by conservative therapeutic measures.

resurfacing of wounds is proving its great value in war injuries, for it saves time, promotes recovery and prevents infection.

B. Thick Split Grafts—The use of this graft, first popularized by Blair,[1] has been greatly increased by Padgett's dermatome.[2] This instrument has made large quantities of skin available from areas from which it is not readily procurable by other means. As a result we can take larger and thicker intermediate grafts, which look better and contract less. (Figs. 1, 2 and 4.)

Undoubtedly, this instrument will contribute to the popularization of skin grafting among many who have heretofore neglected the early resurfacing of wounds because of inexperience with a skin

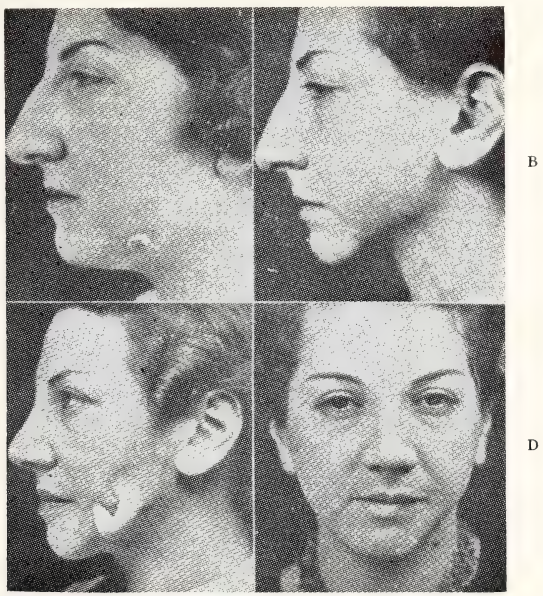


FIG. 5. X-ray burn of cheek with atrophy and telangiectasis following treatment for epulation in woman of twenty-four. A, six years after beginning of treatment an ulcer appeared on the left cheek which proved to be of malignant nature (squamous cell epithelioma). The entire area was widely excised and temporarily covered by a thin skin graft. B, a year later the resulting defect of the cheek was reconstructed by rotation of the skin from the neck. To correct flatness of cheek a dermal graft was inserted subcutaneously but had to be removed because of excessive pressure. In this case the *quality* of the shifted skin was not good enough to sustain the pressure of an underlying dermal graft. C, a tubed pedicle flap from the arm fulfilled the indication in a satisfactory way. A safe transfer of the flap into the irradiated area required considerations relative to its blood supply: longer delaying and a double pedicle. D, end result showing normal contour of reconstructed cheek, also corrective rhinoplasty.

graft knife. However, the fact that these grafts are easily procured and "take" better than full thickness grafts is no reason for using them indiscriminately about the face and neck. We should not look to them for what they are not able to give, namely, perfectly matching color and texture.

My personal experience with these grafts has been disappointing in a number of cases. Although they look better than thin grafts and their "take" is more or less certain, as a rule their color is not good; quite frequently they are conspicuously pigmented. This pigmentation is a great cosmetic flaw because, once developed, it rarely disappears completely. (Fig. 3.)

Thick split grafts do best in areas with a resistant base, like the forehead and chin. On the forehead especially, they are useful for resurfacing the source of a flap.

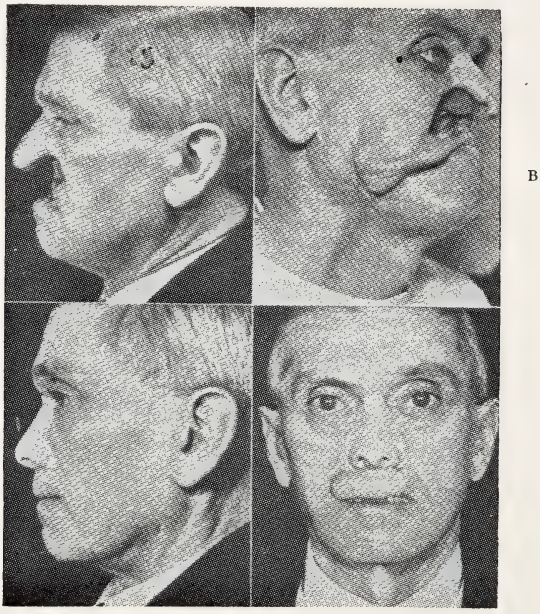


FIG. 6. A, upper lip, hard palate and part of nose were removed for squamous cell epithelioma. B, hair bearing pedicle flap form cheek and upper neck, lined by a free full thickness graft, for reconstruction of lip. Distal end of flap transferred to the left corner of the defect. C, end result showing good contour of lip. Nasal prothesis was provided following total amputation of nose because of recurrence of malignancy.

Since Padgett's dermatome has made large intermediate grafts so easily available, they have proved valuable for the quick recovering of large skin defects of the neck. However, the color and texture of the skin are seldom completely satisfactory nor do they often compare favorably with the end result of a good flap. Here is a case in which economy of time and risk must be weighed against the cosmetic end result. (Figs. 1 and 2.)

In addition to the often unsatisfactory color of these intermediate grafts, they are inclined to contract, sometimes markedly, requiring secondary grafting with full thickness skin. This is most likely to occur in the central portion of the neck over the larynx and on the cheeks in the vicinity of the mouth.

C. Full Thickness Grafts—The full thickness graft is the preferred one of the free grafts for cutaneous covering on the face and for the lining of flaps. Cosmetically as well as functionally, it is superior to all others.

The subcutaneous tissue which these grafts develop in fair amount provides fulness and mobility. They are more difficult to apply, sometimes blistering and showing areas of necrosis in difficult regions; but, with the proper technic, they are employed successfully for the reconstruction of most areas of the face, notably the eyelids, eyebrows, nose and cheeks.

Particularly useful for these parts, because of excellent texture and color, are the full thickness grafts obtained from behind the ear, the upper lids and the supraclavicular region. These grafts, if available in sufficient amount from both sides, permit the grafting of fairly large surfaces. The donor area can usually be closed at once.

Free skin from the inner aspect of the arm is a second choice. For larger defects on the forehead, a free full thickness graft from the abdomen is preferable to an intermediate graft when color and texture count more heavily. The full thickness skin from the posterior aspect of the breast can readily be applied to the face in selected cases. The skin is thin, and usually pale, often matching that of the face in light complexion.

2. Skin Shifting and Rotation

The simplest procedure for the repair of a skin defect, wherever located, is undermining and advancement of the surrounding normal skin to close the defect without tension. To facilitate advancement of the undermined skin, relaxation incisions are often used, permitting a wider range of rotation. Sometimes it requires several stages to cover a defect by this method, depending upon the elasticity of the skin.

The advantages inherent in the use of this procedure on the face are not sufficiently appreciated. Sometimes skin of different color and texture is transferred to the face when skin neighboring the defect could be used. The extra-operative stages required for this procedure are often warranted by the superior end result. This method is contraindicated when the defect is in the vicinity of a facial cavity, and the attempted closure would produce traction and distortion. (Fig. 5B.)

III. Local and Distant Flaps

Tubed and pedicle flaps have numerous absolute indications in the repair of surface defects of the face and neck. In such cases, skin grafts cannot be substituted for them. Indications for their use are as follows: (1) When there is a loss of skin and subcutaneous tissue (Fig. 5); (2) when lining as well as covering must be provided for defects involving nose, cheek or lip (Figs. 6 and 7); (3) in areas with poor blood supply and exposed bone or cartilage.

In order of their importance, the main donor areas for these flaps are forehead, cheek, arm, abdomen and thorax.[3]

Forehead flaps have a special usefulness in the reconstruction of nasal defects; they are superior to any distant skin in color and texture. To avoid conspicuous scarring, I prefer the temporal flap outlined horizontally under the hairline. When this is employed, an attempt should be made to close the resulting defect by mobilization of the surrounding skin, thereby obviating the neces-

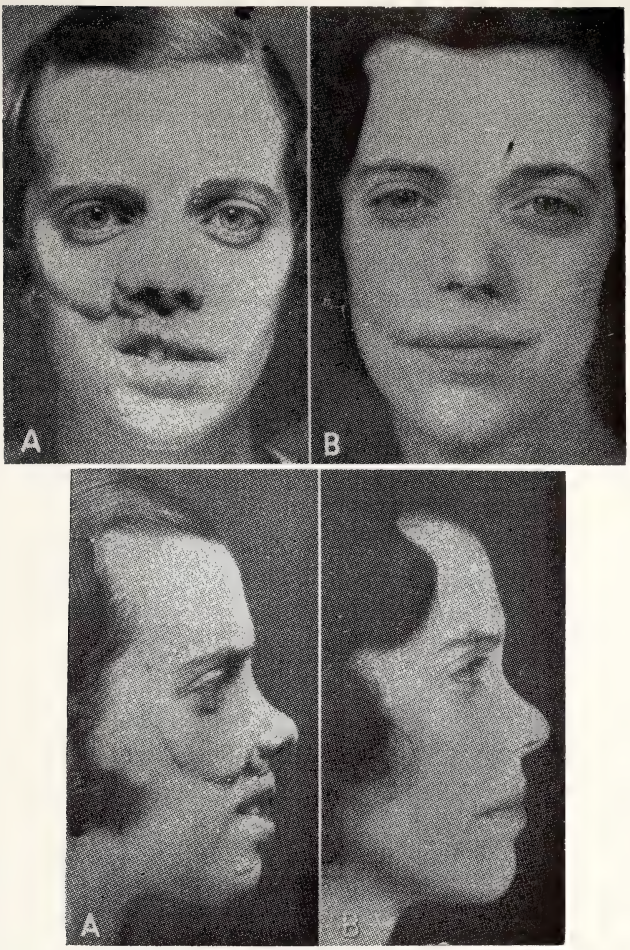


FIG. 7. A, post-traumatic partial loss of skin of upper lip. B, reconstruction by similar procedure as illustrated in Figure 6. Descending pedicle flap from lower cheek was used to cover skin loss of upper lip. No lining was required.

sity for a free graft. The abundant blood supply of forehead flaps permits their transfer in a minimum time .

Ascending and descending flaps from the cheek may be used for reconstruction of the lip, especially in men, and for the reconstruction of the nostrils and nasal tip. (Figs. 6 and 7.) Small flaps from the nose, particularly from the lateral wall, can be utilized advantageously for small losses of nostril.

Horizontal flaps from the neck, with incision placed in the natural fold, are suitable for use about chin and mouth. This same flap, extended toward the mastoid area, provides excellent skin for larger losses of the nose and para-orbital region. The color of the skin is second only to that of facial flaps.

Tubed flaps from the inner aspect of the arm still have frequent indications in the repair of nose and cheek, especially when skin from forehead and neck is not available. (Fig. 5.)

The acromiopectoral flap has not always good color and should be used only when other flaps are unavailable. It is often inadvisable in women.

Although there has been a recent trend toward substitution of split grafts for flaps on the neck in order to reduce the time of

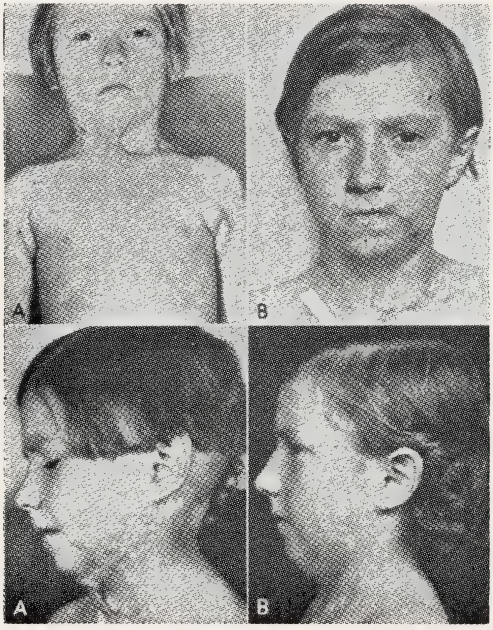


FIG. 8. A, burn scar of neck in young child with strings extending from chin to chest causing recession of chin and obliteration of neck contour. Thiersch grafting of the burned areas done elsewhere in a few stages. B, contour of neck restored by the use of a tube pedicle flap from lateral chest. Color and texture of the skin is good and cannot be surpassed by any other type of graft. Note that the excessive subcutaneous fat which often increases with age partly obliterates the normal contour. Removal of this fat is indicated during the adult age.

repair, this is not always advisable. Especially in young women, the cosmetic factor must be given due weight. From this standpoint, the abdominal flap, or the flap from lateral chest transferred on wrist, provides a better skin covering. (Fig. 8.)

Summary and Conclusion

1. The procedure of choice for resurfacing skin defects on the face and neck must be determined by the patient's age, sex, psychology and finances as well as by technical considerations.

2. While thin free grafts take easily and quickly, their color is not always good and they tend to contract. Full thickness grafts, if available, should be employed as a covering on the face, when good appearance is paramount.

3. Skin shifting and rotation is the simplest method for the repair of skin defects and provides perfectly matching skin. Its use is limited in the vicinity of facial cavities where the attempted closure would produce traction and distortion.

4. Tubed and pedicle flaps are indicated when there is a loss of skin and subcutaneous tissue, when lining and covering must be provided for defects involving nose, cheek or lip, and in areas with poor blood supply or exposed bone and cartilage. The main donor areas for those flaps are forehead, cheek, arm, abdomen and thorax.

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A NEW METHOD FOR REBUILDING A LOWER LID

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A large tumor involving the lids always presents two problems: (1) the treatment of the malignant process and (2) repair of any remaining defect for the preservation of the appearance and function of the lid and the protection of the eye. A number of malignant lesions can, of course, be treated by radium and the roentgen rays, and many can be treated by removing surgically only a portion of the lid. When more than half of the lid is involved and it becomes necessary to remove the greater portion or all of the lid, a major problem in plastic surgery is presented, viz., how to build a new lower lid that will be approximately normal in appearance and function.

For use when the upper lid is still intact, a satisfactory solution has been devised, as shown by the following case report and the illustrations.

Report of Case

HISTORY. — Mr. J. N., aged 64, gave a history of having had a small pimple (?) on the left lower lid for seven years, which he had squeezed at times, obtaining a small amount of discharge from it. In the past few months the edge of the lid had turned in, irritating the eye.

EXAMINATION. — This revealed a growth (fig. 1) involving the major portion of the left lower lid, extending from the punctum to within 2 mm. of the lateral canthus, producing entropion. It was not adherent to bone, but the skin, tarsus and conjunctiva were all involved. Surgical excision of the mass would mean removal of the entire lower lid. This presented two major problems: how to preserve the eyeball and how to reconstruct a useful and normal-appearing lower lid.

PROCEDURE. — The following operation was devised for this purpose and was satisfactory in respect to both the points mentioned.

First Stage: The entire lower lid was removed along lines of dissection represented by the dotted lines in figure 2, the skin and subcutaneous tissues

being severed well below the margin of the mass and the conjunctiva in the lower fornix. Laterally the incision was carried almost to the canthus and medially just beyond the punctum lacrimalis, which was involved. This left a large defect in which a new lower lid was constructed. The skin of the cheek was undermined (figures 2 and 3) sufficiently to allow it to be brought upward to the level normally occupied by the lower lid, without tension. The upper lid was split transversely into two layers, the operator starting along

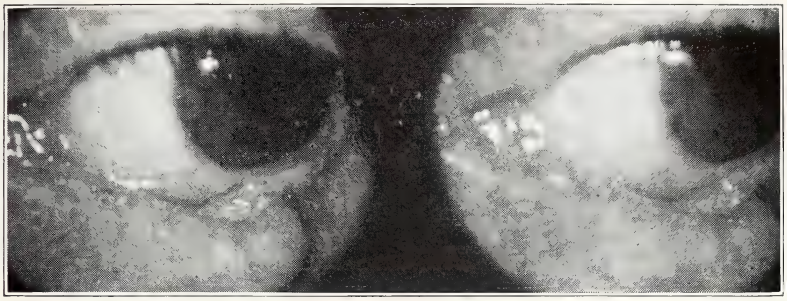

FIG. 1. Stereophotograph showing the original condition. The growth was a basal cell carcinoma of the lower lid.

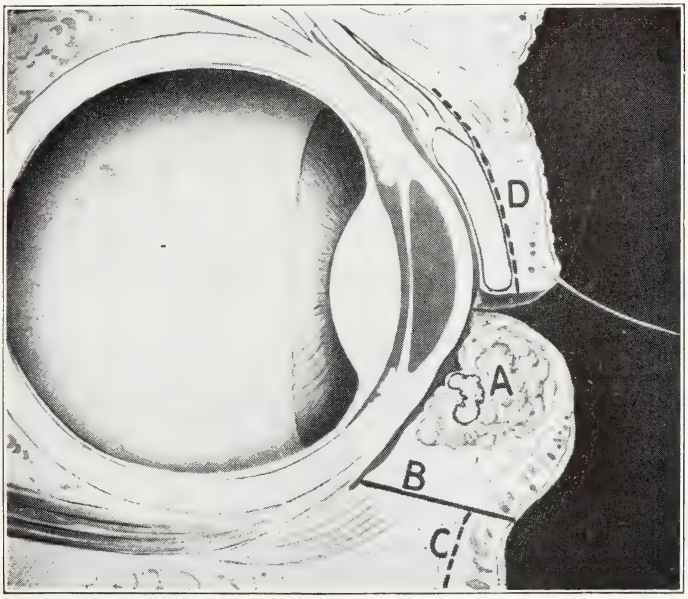

FIG. 2. Diagrammatic cross-section showing: *A,* the growth; B, the line of dissection for removal; *C,* the undermining of the skin to be brought upward, and *D,* the line of dissection in the upper lid.

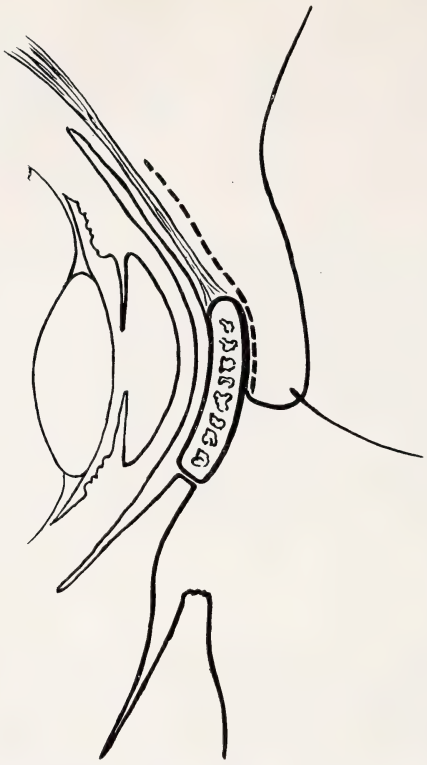

FIG. 3. Cross-section showing the tarsus pulled down and the conjunctiva pulled up to complete the inner layer.

the intermarginal white line and dissecting upward to a point even with the upper fornix about 3 mm. above the upper margin of the tarsus, not disturbing the attachment of the levator to its upper border. Considerable care must be taken to avoid the roots of the lashes in this dissection.[1] The inner layer was comprised of the tarsus with its conjunctiva. The outer layer was the skin and subcutaneous tissue of the upper lid, with the lashes attached. The lower epithelial border of the upper tarsus was cut off, and this edge was united to the cut conjunctival margin in the lower fornix by fine black silk sutures (000 black silk, the sutures being tied so the knots were on the conjunctival surface. The tarsus in the new position, with the levator attached to its upper edge, is shown diagrammatically in cross-section in figures 3, 4, 5 and 6. The previously undermined skin below was drawn upward and attached to the anterior surface of the lower half of the tarsus by means of three double-

[1] In one case in which operation was performed later, the lashes of the upper lid were lost, and it was necessary to transplant new lashes for both the upper and the lower lid.

armed black silk sutures (fig. 4) ; so the upper border was midway between the upper and the lower border of the tarsus. The superficial layer of the upper lid was then attached to the anterior surface of the upper half of the tarsus in the same manner, so that the lashes occupied a transverse straight line parallel and adjacent to the lower edge of the skin across the midportion of the tarsus. The two edges of skin were aligned by a subcuticular stitch, and the external portion of the lashes was held upward to the skin of the upper lid by collodion so that the roots of the lashes would take the proper direction. Rubber tissue was put over the area, and a pressure dressing was applied and left in place for six days. Subsequent dressings were applied at intervals of five days for three weeks.

Second Stage: At the end of six weeks transplantation of lashes was done. A transverse trough was dissected down to the tarsus immediately below and parallel to the lashes of the upper lid (fig. 5). A strip of hairs to fit this trough was cut from the lower nasal portion of the opposite eyebrow and, its position being reversed end to end, was laid in the trough and sewn in position (fig. 6). The hairs were then held down by collodion to the skin of the lower lid to cause them to start growing in the proper direction. Rubber tissue was put over the area. A pressure dressing was applied and left in position

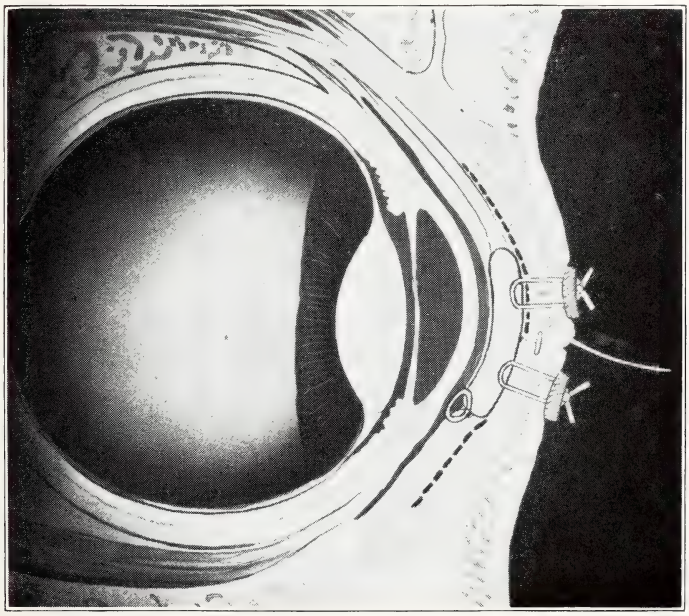

FIG. 4. Cross-section showing the final arrangement of the upper lid with the skin of the cheek pulled up and attached to the anterior surface of the lower half of the tarsus of the upper lid.

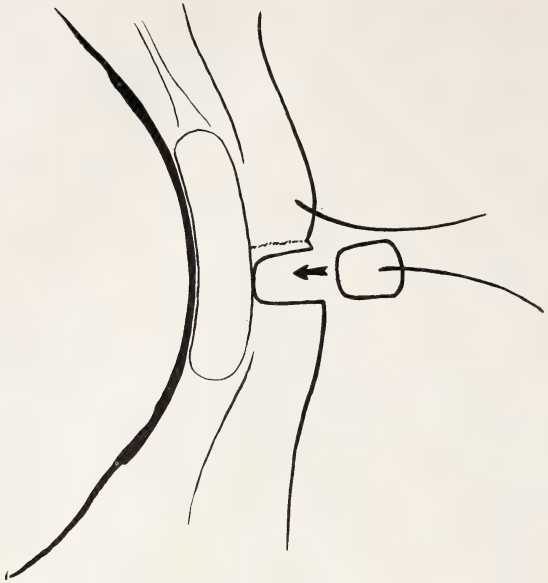

FIG. 5. Diagram showing the trough dissected down to the tarsus to receive the reversed transplant from the lower portion of the opposite eyebrow.

FIG. 6. Diagram showing the transplant in place. The lashes are held down to skin by collodion.

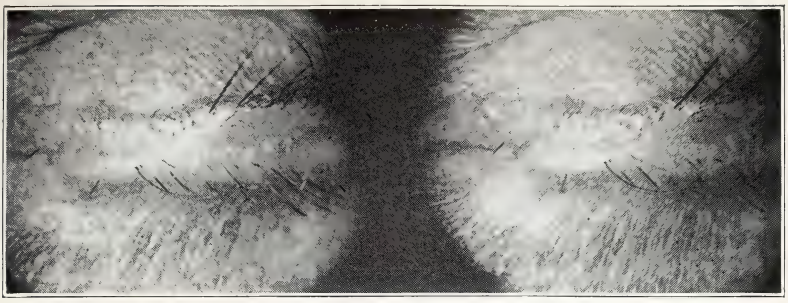

FIG. 7. Stereophotograph showing transplanted lashes in position before a transverse opening is made between the two rows of lashes.

FIG. 8. Photographs taken one month after the final operation. *A* shows the eyes open; *B*, the eyes closed.

FIG. 9. Photograph showing the lower fornix and the transplanted tarsus, with its conjunctiva, in the lower lid.

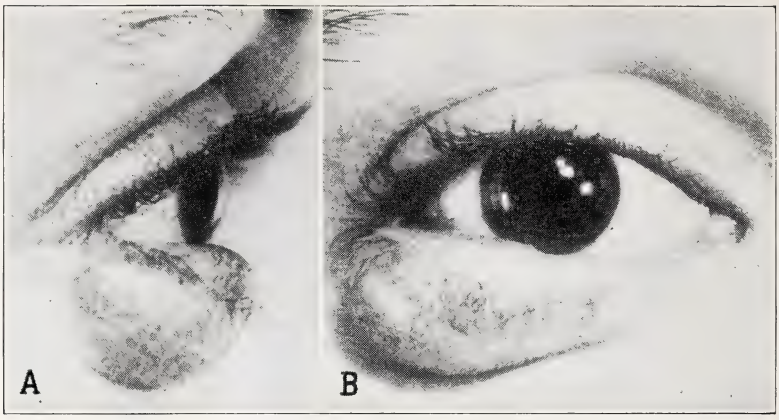

FIG. 10. *A,* side view of an eye with carcinoma of the meibomian glands of the lower lid; *B,* front view of the eye. The procedure described was carried out.

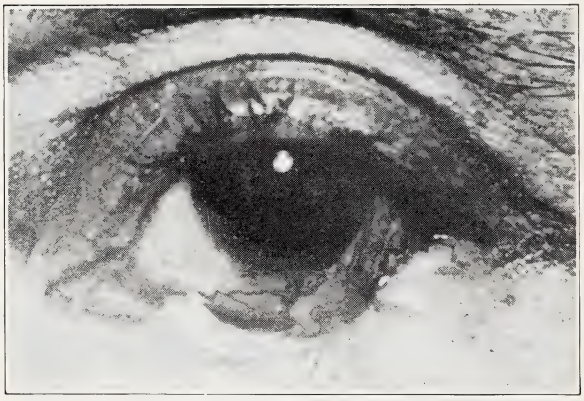

FIG. 11. Photograph of an eye with a basal cell carcinoma of lower lid, on which an operation similar to that described was done.

one week. The dressing was changed again on the twelfth day and removed on the seventeenth day.

The lashes in this strip did not fall out,[1] but kept on growing. The tarsal plate made an excellent smooth base, and the additional raw tissues of the sides of the trough formed by the dissection supplied ample mechanical and nutritional support for the graft. The proper direction of the lashes was ac-

[1] The lashes frequently fall out and later grow in again in the course of two or three months.

complished, first, by turning the transplant so that the portion that was nasal in the right eyebrow was placed nasally in the left lower lid and, second, by anchoring the hairs protruding from the graft to the skin forming the lower lid with collodion in the proper direction (fig. 5). The sutures, which were placed very close to the edges of the skin and tied tightly, were picked off at the first and second dressings, one and two weeks later, respectively.

Third Stage: After another seven weeks, on March 19, 1936, three months after the original operation, when it was seen that the transplanted lashes of the lower lid were growing in the proper direction (figure 7) and the lashes of the upper lid were complete, an incision was made transversely between the two rows of lashes through the skin and tarsus to open the interpalpebral fissure.

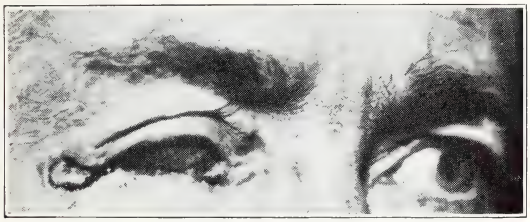

FIG. 12. Photograph showing a basal cell carcinoma eroding the lower lid and the outer and inner portions of the upper lid, besides an area temporally. In this case the operation described was done.

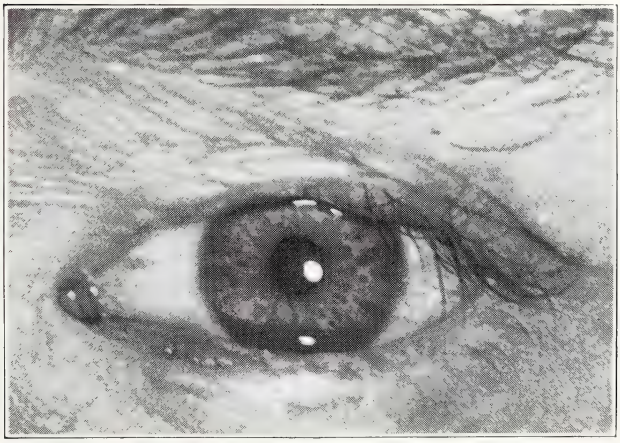

FIG. 13. Photograph of an eye with chronic blepharitis and deformity of the lids, with loss of lashes from a burn when the patient was 5 years of age. The diseased margins were removed; the upper tarsus was pulled down, and the lashes were transplanted for both lids in the manner described.

The new lower lid was now complete except for a punctum and part of the lacrimal canaliculus, which had to be removed because of involvement by the malignant process.

The eye, which was normal in all respects, was preserved intact.

Comment

The type of operation described is applicable in the following circumstances:

1. In any case in which a new lower lid structure is necessary, as

2. For repair of a traumatic injury in cases in which the lid structures have been destroyed or mutilated (Fig. 13).

3. For reconstruction of the margins of the lid in cases of chronic degenerative conditions in which there is deformity or destruction of the lashes and lid structure (Fig. 13) and new lashes are necessary for the upper and lower lids, as in severe cases of ulcerative blepharitis. The resulting lashes are better than when transplanted directly to the margin of the lid.

4. For reconstruction of a portion of the lower lid (Fig. 14). When one half or more of the lid must be reconstructed, this procedure becomes the operation of choice, only the temporal or the nasal portion of the upper tarsus being utilized.

5. For reconstruction of an upper lid, the lower lid being used in the same manner as the upper is now used, with an additional insertion of a thin piece of cartilage or tarsus from the opposite

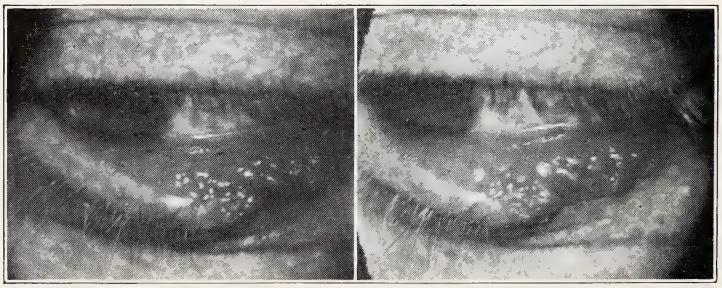

FIG. 14. Photograph showing symmetrical bilateral erosion of the outer half of the lower lids due to infection with Staphylococcus and Streptococcus. In this case the outer half of the upper tarsus was used in the manner described.

upper lid to furnish by the tarsus. There would be insufficient tarsus in the lower lid for both lids.

Transplantation of the tarsus, with its conjunctiva, from the fellow eye would be feasible when structures are not readily available in the ipsilateral lids.

Advantages

1. No additional scars are made in the process of the reconstruction.
2. In the new lids most of the normal structures are represented.
3. The function and appearance of the normal lid are fairly well imitated.
4. The margins of the lids close during sleep.
5. The action of the upper lid is not hampered.

Summary

A case is reported in which an epithelioma was present, involving the entire lower lid, which necessitated its complete removal. A new method of reconstruction of the lower lid was used, the cosmetic and functional results being satisfactory. The upper lid was split into two layers transversely. The inner layer, composed of the tarsus with the levator attached to its upper border, was pulled down and was attached to the conjunctiva in the lower fornix. The skin of the cheek was undermined, pulled up and united to the anterior surface of the tarsus so that its upper border occupied a transverse position midway between the upper and the lower border of the tarsus. This gave a complete closure of the conjunctival sac except for the medial canthus.

One month later a row of hairs was transplanted from the opposite eyebrow to the anterior surface of the tarsus just below and parallel to the upper row of lashes. A pressure dressing was applied and not disturbed for a week.

Three months after the original procedure a transverse incision was made between the two rows of lashes. A complete new lower lid was then present.

In résumé, (1) the skin was undermined and drawn up from the cheek; (2) the tarsus, with its conjunctiva, was drawn down from the upper lid; (3) the lashes from the opposite eyebrow were transplanted. The eye, which was normal, was at no time endangered.

Twenty operations of this type have been performed to date.

Conclusions

A method of rebuilding a new lid, when it becomes necessary to remove the existing one or when the existing one is so badly deformed that it needs reconstruction, has been demonstrated. Normal lid structures are used. When necessary, hairs have been transplanted to provide lashes for both the upper and the lower lid in the same manner.[1] The lashes appear not unlike normal ones because of the smooth, firm bed provided by the tarsus and because their growth in the proper direction can be maintained during the period when the graft is taking.

A movie illustrating this process will be lent to responsible persons. There will be a charge of $5 for handling and express.

[1] See footnote on page 290. When lashes are lacking on the margin of both the upper and the lower lid, as in the case illustrated in figure 14, they may be transplanted into the margin of both the upper and lower lid.

ORBITAL IMPLANTS

By WILLIAM BROWN DOHERTY, MD.
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The tolerance of the orbital tissue to foreign materials has always been well known, and for this reason many substances have been implanted in Tenon's capsule. Most ophthalmologists of the present day concede that something should be put into the socket after enucleation in order to obliterate the unnatural folds and depressions in the upper and lower lids and to prevent ptosis, impaired motility and sinking of the artificial eye.

For this reason aluminum, celluloid, sponge, wool, silver, rubber, silk, catgut, peat, agar agar, paraffin, asbestos, cork, ivory and other substances have been used, with varying success. At present the most common implants are gold balls, glass balls, fat and fascia lata. Each of these has its champions, and I am sure there is no ophthalmologist who has not experienced the unpleasant sensation of finding an implant expelled from the orbit for no apparent reason. The operation seemed perfect; there were no complications; nevertheless, the implantation was a failure.

During the World War, Magitot, after the successes of numerous general surgeons with formaldehyde-treated bone cartilage, adopted it for orbital implantations, and after my return I used it with considerable success at Bellevue Hospital. The material was hard to obtain; so I applied to a large, well known pharmaceutic house for assistance. The staff seemed interested but after referring the matter to their experimental department reported that there was some danger of anthrax infection. There is now on the market, however, an implant made of cartilage which seems to have a great number of champions. In 1 case in which I operated the formaldehyde-treated cartilage implant seemed to be infected, or chemical changes had taken place in the socket, five months after enucleation. I thought best to remove it. This was rather difficult,

as Tenon's capsule was thickened and seemed actually to send proliferations into the cartilage. The failure, I believe, was due to improper fixation and may have resulted from the action of the formaldehyde.

Formaldehyde-treated beef cartilage does after some time absorb (fig. 1). Dr. J. M. Wheeler, in an article in the ARCHIVES OF OPHTHALMOLOGY, mentioned making implants of cork and stated that "a peculiar phenomenom made their use inadvisable. Long after their implantation the tissues in front of them sloughed, and they appeared in the cul-de-sac. Why this happened I do not know, but I suppose that some chemical change took place with a degree of disintegration of the cork, and necrosis of the tissue about the cork." Glass has not proved entirely satisfactory. Dr. Clyde E. McDannald reported a glass implant which shattered in the orbit, apparently as the result of erosion. I know of a similar case. All ophthalmologists have seen artificial eyes in which erosion has taken place. Fat has not proved satisfactory in all cases. There have been liquidation of the fat, shrinkage and occasionally the formation of a lipoma. While gold seems to be most suitable, the

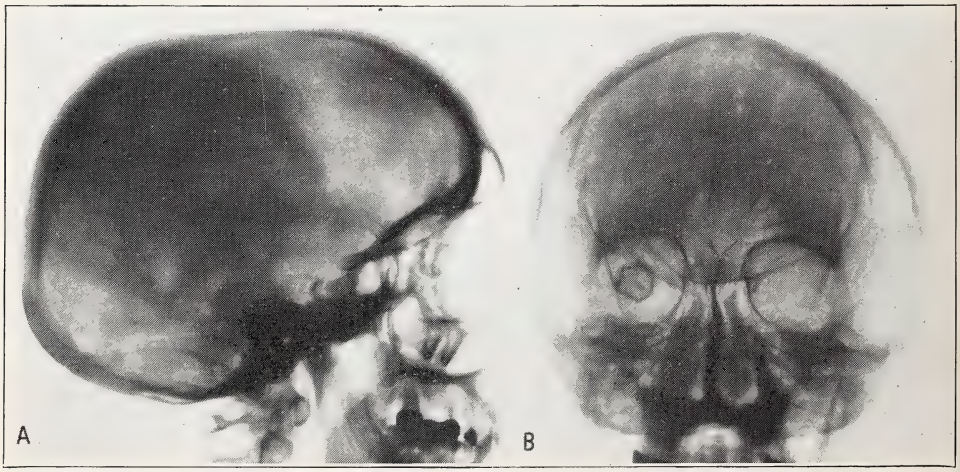

FIG. 1.—*A,* roentgenogram taken eighteen years after implantation of a formaldehyde-treated beef cartilage implant. The case was originally reported in the *American Journal of Ophthalmology* for January 1923. *B,* roentgenogram (same case) showing the fomaldehyde-treated beef cartilage. Note the absorption of the cartilage.

gold alloys sometimes contain only 15 per cent of pure gold and are therefore liable to chemical decomposition. The question as to which substance that has been tried is the best material for orbital implantation resolves itself into another question: Is there a material which will remain chemically (and possibly electrically) neutral in body fluids and will remain entirely silent in the body, apparently creating no change in tissue or in bone?

As metallurgic knowledge increases, particular alloys are developed for specific fields and in their applications exhibit advantages of superior properties not obtainable in the metals of which they are composed. For this reason special alloys are being produced to meet the ever increasing needs in industry for finer, better and more efficient materials. I wish to call attention to an alloy called vitallium, a product of the Austenal Laboratories, Inc.; to the medical uses to which it has been applied, and to the clinical and scientific experiments that have been performed with it. Vitallium has been used in prosthetic dentistry for a long period, That saliva is an electrolyte there can be no question, and galvanic action occurs in the human being from time to time, especially when

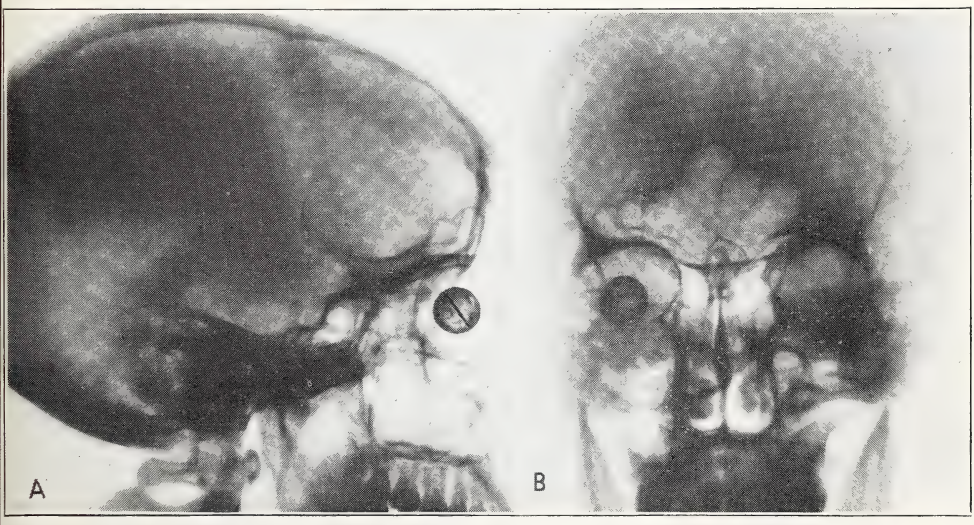

FIG. 2.—*A,* roentgenogram showing a vitallium implant in Tenon's capsule and perfect apposition of the artificial eye. *B,* front view of a vitallium implant in Tenon's capsule. Note the perfect position of the implant in the orbit.

dissimilar metals are used in the oral cavity for filling, crowns and restorations, When vitallium is used in combination with other metals this galvanic action is much reduced. With this in mind, Dr. Charles S. Venable, of San Antonio, Texas, conducted a series of experiments on dogs to establish the reactions between the body fluids and metals. He concluded that in dealing with fractures an alloy should be sought and developed that is entirely inert in the presence of, and unaffected by, biologic salts to the extent that there will be practically no electrolytic action and that it should have the strength to resist such stress or strain as it may have to bear. He accordingly anaesthetized dogs, placing two screws consisting of the various metals and alloys in the bone about 1.5 cm. apart. In all the animals the right radius was fractured and the left radius left intact in order to check the reaction in each dog with and without trauma of the bone. Before the screws were placed, drill holes about two-thirds the size of the screws were made in order to obviate the possibility of undue or variable pressure. After a large number of prolonged and exacting experiments with different metals he reached many conclusions, but he stated that with vitallium there was no tissue reaction or osseous change at the site of any screw, though many experiments were performed with different combinations of metals. Vitallium is a casting alloy, 90 per cent of which is composed of cobalt and chromium, with a smaller percentage of molybdenum. It is designated as a cobalt-chromium alloy. It is exceptionally strong, hard and very light. It has a specific gravity of 8.29, which is much less than the specific gravity of pure gold, which is 19.3, or of casting golds, which ranges from 14.0 to 18.0. I wish to emphasize the difference in weight between a vitallium implant and a gold implant. Vitallium resists strong mineral acids, and a solution of sodium chloride of any degree of concentration over any period produces no effect on it. Vitallium is stronger than gold; it is cheaper than gold; it *can be boiled,* and it lies *inert* in the body tissues. Any implant in the orbit certainly should be sterilized by boiling. Vitallium produces no tissue reaction, and it is not in-

fluenced by heat or by cold as are other synthetic and plastic materials. I have used vitallium orbital implants for over a year and in 6 cases have had no complications and excellent cosmetic results. Some of my colleagues have had similar successes.

Many operators have reported unusual successes in the treatment of fractures with surgical nails, plates, hip caps and special appliances made of vitallium. This material has been used to make a prosthesis when a squamous cell carcinoma on the dorsum of the nose made surgical removal of the nose necessary because surgical restoration was not considered advisable. It has been used to replace parts of the human skull and face, and sufficient time has

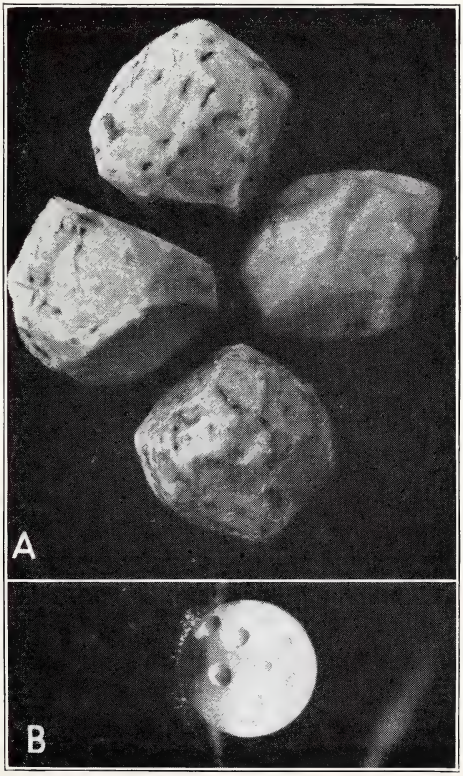

FIG. 3.—*A*, various models of formaldehyde-treated beef cartilage implants used in Bellevue Hospital in 1922. *B*, vitallium orbital implant. The dimpled surface helps to secure the implant in Tenon's capsule and will cause no irritation as might a surface with elevated points.

elapsed to warrant that it has justified the prognosis associated with its use. The disfigurement caused by facial deformities secondary to the malignant tumors of the face has been greatly lessened.

The shapes of orbital implants (fig 3 *A*) certainly are worthy of attention. While experimenting with beef cartilage I tried out a cartilage implant that was practically spherical; that is, the anterior third was cut off flat, the idea being to obtain better motility. In a number of cases the implants became misplaced in Tenon's capsule, no doubt because of the action of the ocular muscles, with resulting strabismus on fitting of the artificial eye. I do not believe that this failure was due to using too small an implant. It is my belief that cone-shaped implants by the presence of their tails in Tenon's capsule limit motion in any direction. The eyeball is normally nearly a sphere, and if it is properly enucleated a spherical implant is the best. In my experience other shapes either become displaced or produce limitation of motion of the artificial eye. The external surface of the implant should by all means be dimpled (fig. 3 *B*), as this materially assists in securing it firmly in Tenon's capsule.

An important detail in any enucleation is the use of the strabismus hook, which should be handled with extreme care. There is much danger of puncturing Tenon's capsule and producing a rent or a tear, and in the presence of a tear, owing to the action of the ocular muscles, the implant slips through the opening and is eccentrically placed in the orbit, with annoying deformity. Figure 2*A* illustrates the correct position of the orbital implant in Tenon's capsule and its relation to the orbital margin. Figure 2 *B* depicts the proper apposition of the artificial eye and the implant.

The dissection should be done entirely with the scissors. Afterward it is permissible to pass the strabismus hook around the globe backward to ascertain whether there are any adhesions that have not been dissected. Another important fact to remember is that a pressure dressing should be kept on for at least ten days to two weeks to obtain consistent results and proper healing.

From a summary of the reports of experimental and clinical uses that have been made of vitallium, backed by recognized

authorities, this substance seems to me to be the one most suited for orbital implantation, and it is my opinion that a globe-shaped implant will give the best cosmetic result, with the least limitation of movement of the artificial eye.

I wish to thank the Austenal Laboratories, Inc., and Dr. Charles S. Venable of San Antonio, Texas, for their kind cooperation in this study.

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JAW RECONSTRUCTION

By V. H. KAZANJIAN, D.M.D., M.D.
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The following discussion will be limited to reconstructive problems of the mandible. It is necessary from the outset to realize the status and importance of the mandible in the body economy. Its main function is that of a support for the dental mechanism. Secondly it has great cosmetic value and supplies the normal contours to the lower half of the face. Finally, because of its close relationship with the tongue and tissues of the hypopharynx, it affects speech and swallowing.

There are many minor deformities of the mandible which are dental in their scope. Irregularities of teeth, loss of teeth, and changes in the alveolar process are some of such minor deformities which will not be discussed here, but which must be mentioned, since they affect mastication and phonation, two primary functions of the mandible.

The three major types of deformities consist of: (1) those in which there is loss of bone with the continuity of the mandible definitely disturbed; (2) those in which there is maldevelopment and retrusion of the mandible; (3) those in which overdevelopment of the mandible such as occurs in prognathism, open bite, etc., is present. Subdivisions to these main topics will be made below.

1. Bone Loss in the Mandible

The main causes of important loss of bone in the mandible are osteomyelitis, trauma — especially gun shot wounds — and surgical intervention for the removal of new growths. The destruction caused by osteomyelitis varies in extent. Unless the final defect leads to definite loss of continuity, it does not create a major problem for the reconstructive surgeon. In radiation necrosis, on the

other hand, eventual loss of bone is usually quite extensive. In one of my cases, the necrotic mandible had to be removed entirely.

Loss of continuity of the mandible is accompanied by distortion and poor function to a varying extent. When the continuity of the mandible is disturbed, the muscles of mastication lose their normal coördinated action. As a result their individual actions pull the mandible in various directions. This, combined with cicatrices of the surrounding soft tissues may cause considerable distortion of the remaining bony fragments.

Trauma as a cause of bone loss in the mandible is a direct factor in gunshot wounds; indirectly, it is a factor in producing compound fractures and osteomyelitis.

One of the main causes of loss of mandibular bone is surgical intervention for the treatment of benign or malignant tumors of the jaws. Carcinoma, fibrosarcoma or osteogenic sarcoma are the three main types of malignant disease affecting the mandible. Of the benign growths, adamantinoma and benign giant cell tumors commonly cause important defects in the bone. Deformities from malignant disease are not favorable cases for effective reconstructive surgery, as surgical treatment is primarily concerned with combating the recurrence of disease. In non-malignant tumors, however, one takes greater liberties, as such patients are often young and the chances of recurrence are almost nil if operation is performed radically.

Adamantinoma occurs in the young and as the surgical treatment consists of the removal of a section of mandible, there often results a large defect which frequently involves almost the entire half of the mandible, and occasionally the median section of the mandible. Benign giant cell tumors of central origin, if extensive, are also treated radically.

In the treatment of mandibular defects resulting from loss of bone two procedures are available: (1) the transplantation of bone; or (2) the construction of a prosthetic appliance. Transplantation of bone is the method of choice and it is most satisfactory to the patient. There are times, however, when owing to surgical difficul-

FIG. 1. X-ray showing tumor mass extending from angle of jaw to median line of mandible. (Case 1.)

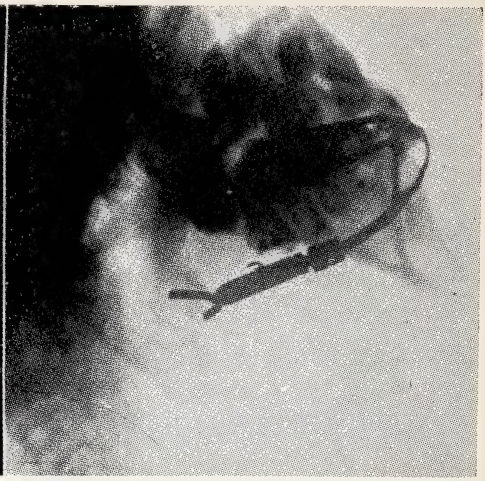


FIG. 2. X-ray following removal of tumor mass including section of mandible — splint in position. The splint consists of a stout arch wire attached to metal bands which were fitted over selected teeth on normal side of the mandible. An adjustable fork was connected to the end of the arch wire which was fastened to the stump of the ramus following operation. The distance was regulated by a threaded nut which held the ramus as far back as was necessary. Case 1.)

ties or to the patient's unfavorable physical condition and many other factors, it is advisable to use a prosthetic restoration either as a temporary expedient or as a permanent therapeutic measure.

Transplantation of bone is most favorable when the defect is within the body of the mandible. It becomes increasingly difficult as the loss of bone involves the ramus or includes the condyle. This is partly due to difficulties incident to immobilization of the parts following operation.

A. METHODS OF BONE GRAFTING. — The fundamental principles of bone transplantation are the same in any area of the body. (Mercer.[1]) The particular difficulties encountered in the jaw are compensated for in general by the richness of the blood supply present. The oral cavity is always contaminated and presents a hazard if entered during surgery on the jaw. The degree of available postoperative immobilization is often limited.

Since the World War, surgical restoration of the continuity of the mandible has been brought about by two methods: (1) the massive bone graft, preferably taken from the crest of the ilium; and (2) osteoperiosteal grafting. Both procedures are useful. Ivy and Curtis recommended osteoperiosteal grafts for defects of the mandible 2 cm. or less in extent, and in cases where the external contour of the face showed little or no deficiency.

The writer prefers osteoperiosteal grafts even in larger defects. However, the method of bone grafting adopted is different from that which Delaginière first described. My procedure consists of using osteoperiosteal transplants taken from the tibia about 2 mm. in thickness; where bulk is a factor several pieces are used. My reasons for adopting this method are: (1) this type of graft contains all the elements necessary for osteogenesis; (2) it is sufficiently flexible to use in many cases; (3) the technique of removal and insertion is simple; and (4) when used severally they give as sufficient bulk as desired.

Preoperative Preparation of the Patient. — In the preparation of the patient, the general physical condition must be carefully evaluated. Any acute or chronic illness definitely increases the surgical hazard. Metabolic diseases and deficiencies must be recognized. Finally the operative area must be free from infection. This point is not always easy to determine. The passage of time since the primary condition or surgery helps to rid the area of infection. A six months' wait may be stated to be the minimum after any suppurative process.

In the occasional case, preliminary surgery may be more extensive and painstaking than the final transplantation of bone. This will be true when the soft parts need reconstructing in order to prepare a bed for the receptio of the transplant. The use of delayed flaps and various plastic procedures may be required.

Sometimes the correction of alignment may be the primary purpose of one's preliminary operation. Finally the operator must carefully prepare his splints for postoperative immobilization after transplantation. The presence of teeth to act as abutments for splint

attachments are so important that their absence may cause the surgeon considerable handicap.

CASE 1 — S. L., age 12. Two years before this boy's first admission to the Massachusetts General Hospital, August 1, 1925, his parents noticed a swelling over the right cheek which was caused by a tumor mass of the lower jaw. This increased in size during the next two to three months.

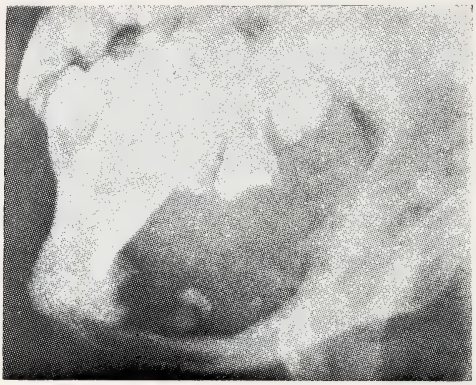


FIG. 3. X-ray of jaw three years after osteo-periosteal transplant. (Case 1.)

He was operated upon at a local hospital, and had an uneventful convalescence. For the next two to three months the mass was smaller in size; it then increased to a size larger than it had previously attained.

Examination on admission showed a hard swelling of the right side of the face involving the mandible. The tumor mass was smooth in contour and firmly attached to the bone. It extended from the angle of the jaw almost to the median line. X-ray showed a cyst-like mass occupying the greater part of the body of the mandible. (Fig. 1.) Its outline was sharply lobulated and it contained coarse trabeculae. The diagnosis was sarcoma or giant cell tumor. Operative treatment was advised.

Previous to operation models were taken and a splint constructed. The operation was performed under avertin and intranasal ether. A semicircular incision about 15 cm. long was made, extending upward toward the lip. The right side of the body of the mandible was excised with a saw and bone-cutting forceps. The wound of the floor of the mouth was closed, and the skin closed over a pad and rubber drain. The previously prepared splint was adjusted. It encircled several of the teeth on the left and engaged by an adjustable fork, the stump of the ascending ramus on the right side. (Fig. 2.) The patient made an uneventful recovery and was discharged from the hospital on August 30, with the appliance in position.

At his second admission, January 31, 1933, the boy was in good physical

condition, and there was no evidence of recurrence of the tumor. It was decided to operate and transplant an osteoperiosteal graft.

An incision was made along the old scar and the mandibular stumps were freely exposed. Two pieces of osteo-periosteal graft, about four inches long and one-half inch wide, were removed from the left tibia and transferred to fill the gap in the mandible. The transplants were held in position by buried sutures. The jaws were then immobilized by wiring. The patient made an uneventful recovery and was discharged from the hospital on February 8, 1933. (Fig. 3, final *x*-ray.)

Remarks. — This case illustrates the importance of maintaining the two parts of the mandible in their normal position immediately after the sectioning is done. This patient was able to tolerate the intraoral dental splint one end of which was fastened to the lower end of the ramus, from August 15, 1925 until long after the bone graft was inserted.

Case 2 — N. A., 11 years old. This girl had a non-malignant tumor removed from the lower jaw on August 3, 1937. It had been necessary to excise part of the mandible extending from the neck of the right condyle to the second biscuspid region. (Fig. 4.) In order to maintain the remaining

Fig. 4. X-ray showing defect of bone, extending from the neck of the condyle to the bicuspid region. (Case 2.)

Fig. 5. X-ray showing transplant extending from the neck of the condyle to the bicuspid region, six months after operation. (Case 2.)

part of the mandible and the occlusion of the teeth in their normal position the following simple method was used: brass wires, 20 gauge, were passed around the upper and lower premolars and their twisted short ends were bent to form hooks. Elastic bands were extended from the upper to the lower hook in such a direction as to prevent the mandible from displacing backward.

From then until the patient was ready for the next operation for bone

grafting September 3, 1937, the elastic bands were used as an effective and easily adjustable method of retention. Repeated *x-ray* studies were made during the follow-up of this patient but new bone formation was very limited. On September 23, 1937, it was decided to transplant bone.

The patient was operated on under ether anesthesia on November 1. An incision was made over the right temporomandibular joint and carried down to the capsule of the joint. By blunt dissection the ramus of the jaw was explored. A second incision approximately at the angle of the jaw was then made and the dissection carried upward until the two met. From the tibia cortex a 6×2 cm. rectangular section of bone was obtained. A similar smaller shaving was also taken. The large piece was slipped in from below upwards to articulate with the temporomandibular region. The patient was returned to the ward in good condition after both jaws were wired together in proper occlusion.

Immobilization of the jaws was maintained for a long time. On January 6, 1938, the wires were removed. On February 10, good union, good occlusion, and good excursive movement of the mandible were present. (Fig. 5.)

Remarks. — In pathologic conditions necessitating the removal of the ascending ramus, I would suggest that surgeons spare the head and neck of the condyle if these are not invaded by disease. My reason for this suggestion is that future reconstruction by bone grafting is more favorable if the head of the condyle is present.

B. Prosthetic Restorations. — Since the main purpose of our surgery in these cases is the reestablishment of function in the mandible, it is necessary to discuss briefly prosthetic considerations. One point often not recognized is that a good prosthetic appliance will make possible and establish function in the remaining part of the mandible. It can be commonly observed that destruction of one condyle, or even part of the ramus, does not necessarily indicate loss of functional power. Neither does it show any marked degree of external deformity, provided the normal action of the jaw is not handicapped by adhesions and scars. The situation is reversed, however, when the missing bone involves, in addition to the ramus, any part of the body of the mandible anterior to the attachments of the masseter muscles.

Artificial restoration of the mandible has definite problems of its own. Unlike the maxilla, the mandible depends on active movements for its function. The primary object is to preserve the func-

tioning of the remaining part and to a lesser extent restore the face to its normal contour. The degree of functional power is dependent upon the size and anatomic position of the existing bone, and upon the presence or absence of teeth. The remaining part of the mandible is usually distorted laterally and backward, disturbing the occlusion and the normal functioning of the teeth. The temporomandibular joint is completely obliterated and the unaffected side of the face is more or less flat.

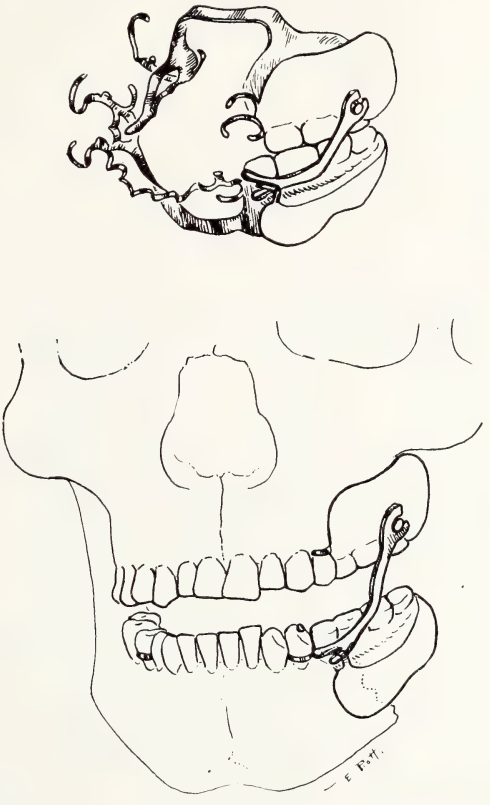


FIG. 6. This appliance was made for a patient operated upon for adamantinoma of the left mandible. The missing bone extended from the left bicuspid region backward. The appliance consisted of two dental plates connected by a bar at upper end of which was a hinged joint. The fork at lower end rests on a small bar incorporated in the lower plate. As the mouth opens there is no disturbance of the lateral motions of the jaw. When the teeth are in contact the bar forces the lower jaw into normal position.

The first step is to correct the distortion of the existing segment of the mandible so that the remaining teeth will be in normal position. In favorable cases this may require only a certain amount of mechanical manipulation with orthodontic appliances; in others, complicated by the presence of cicatrical tissue, it may be necessary to eliminate such handicaps by surgery as a preliminary step to prosthetic restoration.

Two types of appliances may be used quite successfully. First, a retention appliance, its main function being not so much to correct facial contour as to facilitate the functioning of the remaining mandibular segment. Such an appliance may extend from the last tooth of the anterior segment on the defective side, backward and upward toward the maxillary third molars, where a pseudo-temporomandibular joint is made in the form of either a groove or a ball-and-socket joint. (Fig. 6.) The fundamental purpose of this appliance

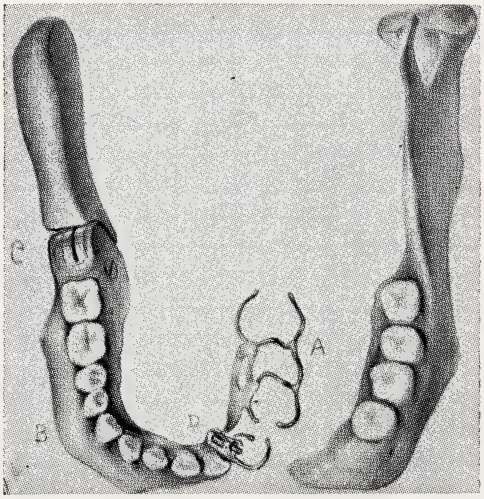


FIG. 7. Permanent prosthesis, following extensive resection of the mandible. As seen in the diagram, the appliance consists of two main sections: *A,* series of crib clasps fitted over selected teeth on left side; *B,* a vulcanite plate more or less shaped to the contour of the mandibular bone designed to replace the missing segment. There are two hinged joints, one at the angle of the artificial ramus, *C,* the other at the junction of the clasps and vulcanite plate, *D.* The purpose of these joints is to give more flexibility to the apparatus and to prevent undue strain on the teeth carrying the clasps.

would be to prevent the backward and inward swing of the remaining segment of the mandible.

The second type may be called the artificial jaw type of appliance and is useful only in rare cases. With this appliance deformity and disability are avoided from the beginning. The method consists of introducing into the wound an artificial restoration, the approximate size and shape of the bone removed, extending from the articular eminence to the stump of the remaining mandible. (Fig. 7.) The restoration stays in position until the wound has healed, but not infrequently skin grafting within the buccal cavity becomes necessary to avoid contractures. The final prosthesis is made with attachments to be fastened over the remaining teeth. This method was first advocated by Claude Martin, and has been elaborated and perfected by our European colleagues, including Schroeder, Ernst, Pichler and others.

During the World War it was conclusively demonstrated that for successful plastics of the lip, cheek, and chin, when the destruction involved the maxillary and mandibular bone, it was necessary for the prosthetic appliance to be constructed prior to the operation for repair of the part.[2, 3, 4] This is also true in civilian life, with patients who undergo operative treatment for the removal of various tumors. Thus we see the close relationship of surgery and prosthesis; and on this basis, we may justly consider surgical prothesis as a branch of restorative surgery.

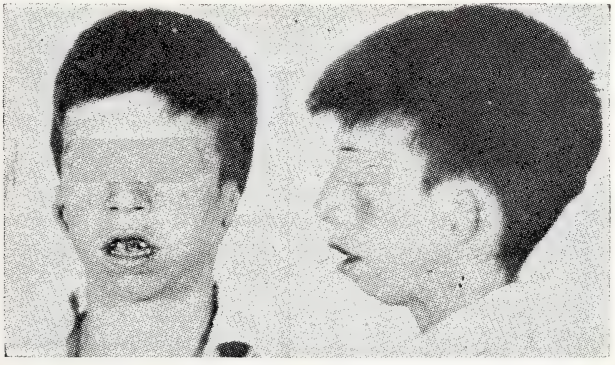


FIG. 8. Case III, showing symmetrical bilateral retrusion of the mandible. (From Kazanjian, in *Internat. J. Orthodontia,* 22:259, 1936.)

2. Symmetrical Bilateral Retrusion of the Mandible

In patients with symmetrical bilateral retrusion, the mandible is uniformly small and it is markedly retracted in relation to the upper jaw. (Fig. 8.) Not infrequently the symphysis menti is not developed normally, thus exaggerating the deformity of the lower half of the face. Examination of the teeth in these cases shows a considerable horizontal space between the upper and lower anterior teeth.

This deformity may be congenital in origin, but most frequently is due to arrested growth of the mandible because of (1) birth injury, (2) trauma, (3) infection involving both sides of the mandible, or (4) bilateral ankylosis at an early age.

It is difficult causally to relate birth injury to the decreased growth of the mandible and unless the birth injury caused an overlapping fracture or was followed by osteomyelitis there is no reason to suppose that mere fracturing of the infant's jaw should affect the mandibular growth. Case 3 (K. C.) gave a history of severe birth injury, but he also had bilateral congenital microtia, so it is not certain whether or not this and similar cases are congenital or traumatic (birth injury) in origin.

Retrusion of the mandible may result from maltreated bilateral fracture of the necks of the condyles, where the head of the condyle is pushed out of its socket, the effect being retraction of the entire mandible, backward, with open bite.

In bilateral ankylosis in childhood, generally there is a symmetrical lack of growth, but the predisposing cause is not the lack of functioning of the jaw but the original trauma or infection which disturbed the growth centers of the jaw and led to underdevelopment of the mandible. This point is well illustrated in cases where there is asymmetrical retrusion of the jaw in unilateral ankylosis. Here the function of the jaw is lacking, but while the affected side is considerably shortened, the non-affected side of the mandible grows to almost normal size.

Treatment. — Marked deformities of this type in young patients should be corrected surgically with the hope of improving the

occlusion of the teeth and relieving the patient of a marked deformity.

Preoperative measures should include a careful study of the existing relations of the upper and lower teeth, and of the possibility for improving the occlusion after the operation. One has to consider the possibilities of future orthodontic and other dental treatment for increasing masticatory power of the teeth. It is sometimes better to limit the advancement of the mandible to less than the ideal esthetic position for such reasons. Purely cosmetic surgery is always possible by building up the chin with cartilage grafts in front of and at the sides of the symphysis. As the operation itself consists of advancing the mandible by cutting through it on each side, it is important to make provisions for immobilization of the mandible following the operation. Thus adequate dental splints become a necessary prerequisite.

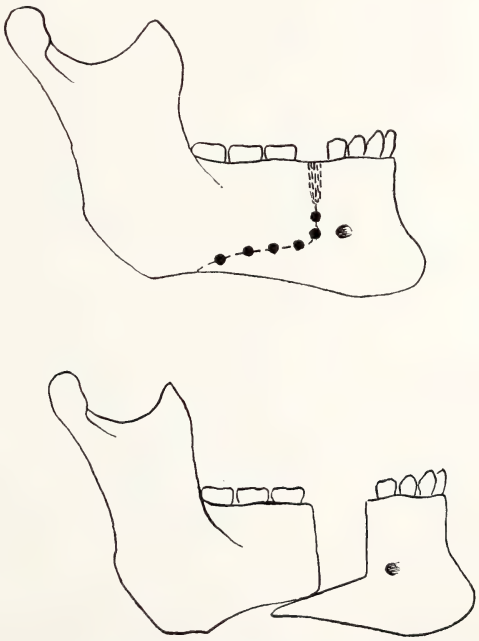


FIG. 9. Diagram showing L-shaped sectioning of the mandible. The lower arm of the L should be long enough to have contact with the posterior portion of the mandible when the anterior part is advanced.

Operation for Retrusion. — The most important surgical procedures are: (1) advancing the mandible forward; (2) correcting further deformity by dental treatment; and (3) transplanting bone or cartilage along the median or lateral surfaces of the mandible as necessary.

Various methods are advocated for the advancement of the mandible. These consist of: (1) cutting through the ascending ramus; (2) approaching through the body of the mandible; and recently, (3) transplanting a piece of cartilage posterior to the head of the condyle. (See Babcock.[5]) Of these several methods, the simplest and most logical procedure is to advance the body of the mandible. (Fig. 9.) The operative approach is through the buccal cavity. Local anesthesia is preferable in adults, but children are operated on under general anesthesia.

1. The second premolar tooth is sacrificed and a U-shaped incision is made through the buccal mucous membrane. The lateral surface of the mandible is exposed from the mental to the retromolar region.

2. The mental foramen is located and exposed.

3. With a small surgical burr (No. 6) holes are made through the mandible, at first vertically, from the socket of the extracted premolar to some distances below the mental foramen, in order to insure against damaging the roots of the teeth. At this point the holes are made in a horizontal direction, as far as the operator thinks necessary to insure bony contact of the two fragments after advancement of the mandible. The bone between the holes is then cut through with surgical burrs.

After this procedure, sharp axe-shaped chisels may be used to fracture the bone completely. During this cutting process saline is flushed into the area and continually aspirated with suction, thus keeping the field clear of blood.

4. The same procedure is applied on the other side, and the anterior segment of the mandible is brought forward and immobilized in its new position. If the patient is operated upon under general anesthesia, wiring of the upper and lower jaws is postponed

until the patient is free from postoperative vomiting. However, properly made dental splints will afford enough fixation of the fragments without intermaxillary wiring.

5. In order to get the maximum effect from this operation it is necessary to use external pull on the symphysis to obtain a more exact and controllable advancement of the chin. This is effected by passing a wire suture directly through the symphysis and attaching to this an elastic band leading to a bridging arch of wire coming down over the midline of the face from the forehead. The wire arch or bridge rests on a forehead frame imbedded in dental composition and also on a band on the upper incisors. An extension over the chin affords a point of attachment for the elastic band. (Fig. 10.) A stab wound is made leading under the jaw line

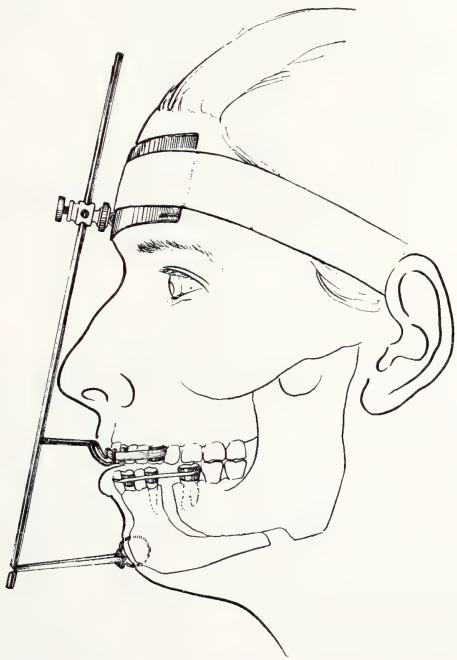


FIG. 10. Diagram showing method of pulling the chin forward after sectioning of the bone. The median bar is anchored to the forehead and the upper teeth. A brass wire is passed through a hole at the symphysis and comes through the skin so as to form a loop in front of the chin. An elastic band extends from the wire loop to the bar in front.

externally and a rubber dam drain is placed in that site (removable externally). The intraoral incision wound is then sutured.

6. If the described surgical procedure is not sufficient to gain for the patient the necessary prominence of the chin, it is possible some months later to transplant a section of rib cartilage or preferably bone, over the anterior surface of the symphysis.

CASE 3—K. C. This boy (Fig. 8), first seen when fourteen years old, had congenital microtia, right and left, and a deformity of the chin. The patient's early history is rather confusing. The parents attribute his condition to a birth injury, but the deformity of the ears is definitely congenital, and there is every reason to believe the underdevelopment of the chin is also con-

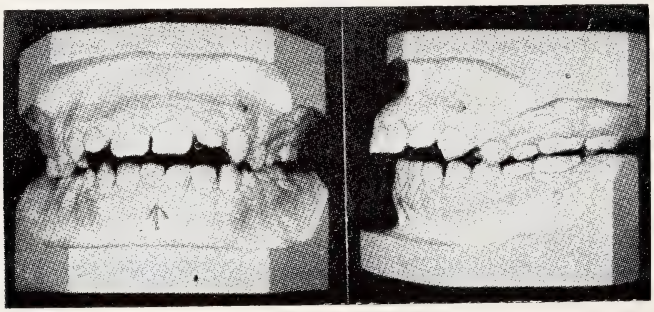


FIG. 11. Models of patient (Case III) showing relation of lower teeth to the upper prior to operation. (From Kazanjian, in *Internat. J. Orthodontia,* 22:259, 1936.)

FIG. 12. Case III, after operation in which two pieces of rib cartilage were inserted in front of the symphysis. (From Kazanjian, in *Internat. J. Orthodontia,* 22:259, 1936.)

genital. Examination of the teeth was interesting as the patient had retroclusion with excessive fullness of the maxillary alveolar arch and a separation of the anterior teeth. (Fig. 11.) After consultation with the Orthodontic Department, it was decided not to disturb the existing occlusion of the molars and bicuspids, but to remove a maxillary bicuspid on each side and push the maxillary anterior teeth back with orthodontic appliances. This was considered advisable because of the excessive fullness of the maxillary alveolar arch. While the orthodontic treatment was being carried on, the patient was admitted to the Massachusetts Eye and Ear Infirmary for the surgical treatment of the microtia and the deformity of the chin. I shall omit here the details of treatment of the microtia. Two operations were performed for transplantation of rib cartilage to the chin, with rather gratifying results. (Fig. 12.)

Unfortunately, regulation of the teeth met with difficulties and after studying the deformity more carefully it was apparent that mere regulating of the teeth was not a satisfactory solution of the defority. While the patient was at the Eye and Ear Infirmary for operation on microtia, it was considered advisable to do an osteoplastic operation and advance the jaw forward.

The operation was performed Oct. 1, 1938, under novocaine anesthesia along the lines described in the text. The improvement of occlusion of the teeth and of the facial contour was immediate. (Fig. 13.)

FIG. 13. Final photographs of patient (Case III) following advancement of the lower jaw.

Asymmetrical Retrusion of the Mandible

Asymmetrical retrusion of the mandible is a distinct type of deformity and is seen more frequently than bilateral symmetrical retrusion of the mandible. It has the same etiologic factors except that close examination will show arrested development of one side

of the mandible only. Thus the unaffected side is longer when measured from the center of the chin to the tragus of the ear — sometimes as much as 2 or 3 cm. The picture is quite typical. (Fig. 14.) The chin is markedly retracted and deviated to the

FIG. 14. Case IV, showing asymmetrical retrusion of the mandible. Note the shortness of the mandible on the right side, which is the main cause of the deformity.

short side of the mandible. The face is flattened on the unaffected side and full on the affected side, a point which may lead to a mistaken diagnosis. The deformity varies directly with the earliness of the onset.

Examination of the mouth often shows the posterior teeth on the affected side to be missing. The occlusion of the teeth may be disturbed considerably. The normal vertical axis of the teeth is changed to the opposite direction, so much so, that the lower teeth instead of slanting buccally are bent medially. This process takes place gradually as the child grows.

OPERATIVE TREATMENT. — Surgical treatment in such cases consists primarily of elongating the short side of the mandible. However, here again one must consider the effect of correction on the dental mechanism. Therefore, the same study and preoperative measures are as essential as in the cases of bilateral symmetrical deformities.

The operative method which I have adopted, is to make a

diagonal or L-shaped incision through the short side of the mandible with a surgical burr, and to elongate it as much as is practical. (Figs. 9 and 15.) Often the occlusion of the posterior teeth is considerably disturbed but this is later corrected by orthodontic measures.

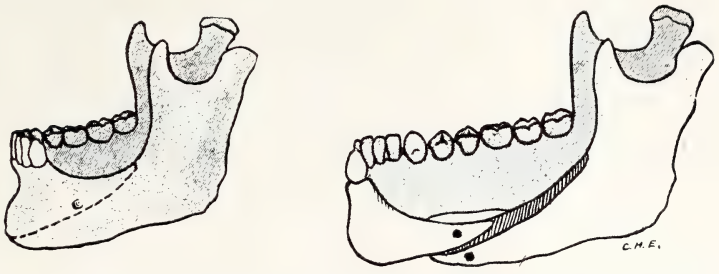


FIG. 15. Diagram showing diagonal cut through the body of the mandible for the lengthening of the short side of the mandible. This method is useful when the affected side is edentulous. (*The Appollonian,* Jan. 1937.)

The immobilization of the resulting fractures is effected by suitable dental splints if sufficient teeth exist on each side of the fragment. If teeth are not available, holes are made in the extreme ends of the disconnected bone with a surgical burr. A stainless steel wire (No. 20 gauge) may be used to connect the two ends together. The twisted wire is allowed to protrude through the mucous membrane By this procedure as much as an inch of lengthening may be obtained. The wire sutures are removed in due time, and they rarely cause any disturbance.

If additional improvement of the facial contour is desired, transplantation of bone or cartilage is resorted to at the symphysis or even at the side of the mandible.

CASE 4. — K. R. I first saw this patient November 18, 1927. Her parents stated that she had had a severe infection that broke out on her face, hands and thighs, eight days after birth (cesarean). Since then the jaw had grown progressively deformed. (Fig. 14.)

The patient was not seen again until November 24, 1936. She had been receiving orthodontic treatment, but it had not been of much benefit. The lower right second bicuspid was extracted and splints were constructed to be used following operation for lengthening the jaw.

On September 7, 1937, an operation was performed under ether anesthesia. An incision was made over the alveolar crest of the right mandible, rather far back. The mucous membrane was incised and stripped back, exposing the outer aspect of about one-third of the body of the mandible. With the bone drill an L-shaped section was made through the mandible, the short vertical arm in the molar region and the long horizontal leg of the L running slightly downward until it passed through the inferior border of the mandible. (Fig. 9.) A drill hole was made in the tip of the anterior section of bone near the inferior margin and a wire suture was passed through this and brought out to the surface of the chin. A stab wound was made to the outside, under the border of the mandible, and a rubber dam drain brought through and sutured to the chin. Previously prepared dental splints were attached to the teeth on either side of the section and a bar was fixed which spread the mandibular fragments apart to the desired extent and fixed them in position. Pressure dressing was applied to the outside of the face.

Immediately following the operation a special splint was devised to effect a direct pull on the anterior fragment at the symphysis. (Fig. 10.) This splint was supported at the forehead and over the upper teeth, and extended in front of the chin. It pulled on the symphysis by the force of rubber bands extending from the metal bar in front of the chin to the wire loop from the symphysis. It was maintained in position for about ten days. (Following this the patient was seen at my office, and a certain amount of orthodontic work was accomplished in the way of improving the occlusion.) When the patient was seen on December 20, 1937, complete consolidation of the jaw was found, with marked improvement of the facial outline. She was discharged until the following summer.

On July 21, 1938, a second operation was performed, the purpose of which was to improve the contour of the chin and left side of the jaw. Under ether anesthesia, an incision was made along the crest of the right tibia. Two good sized pieces of bone were obtained from the tibial crest. These were each roughly 3×5 cm. in their dimensions. An incision about $2\frac{1}{2}$ inches long was made under the chin line. Through this the skin was undermined freely down the neck and a deeper dissection was also carried out, releasing a fat flap which lay underneath the chin. This was removed, piecemeal, reducing the contour of the under chin. With the periosteal elevator, largely by blunt dissection, the periosteum of the chin proper and to the left of the chin was exposed and elevated. Both the fragments of bone obtained from the Tibia were planted, one directly over the mental protuberance and the other laterally. These pieces contributed to the yielding of a more prominent chin, and filled out the depression at the left of the chin. A small rubber dam drain was applied down the neck.

Following this operation the contour of the chin was quite satisfactory. (Fig. 16.)

FIG. 16. Final photographs of patient (Case IV). In addition to lengthening the short side of the mandible two pieces of bone transplant were added to the chin and to the left side.

Since the first operation the patient has been under the care of an orthodontist (Dr. Blumenthal) who has accomplished considerable improvement of occlusion of the teeth.

Remarks. — In an operation of this type one is obliged to disturb the occlusion of the existing teeth more or less, but in young patients judicial orthodontic treatment combined with various types of dental restorations have given satisfactory results.

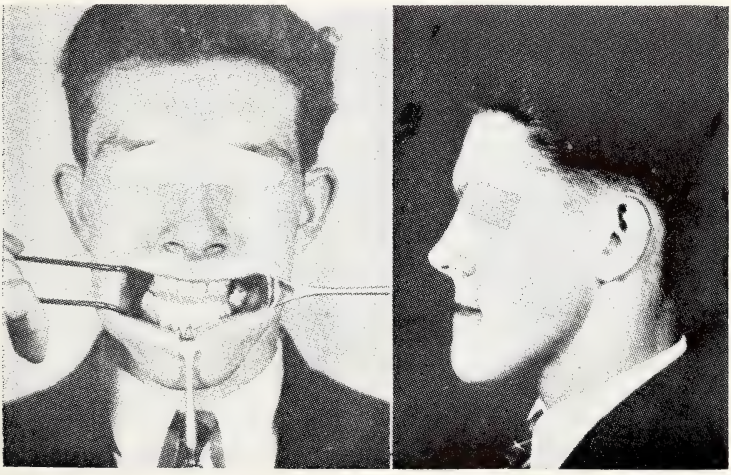


FIG. 17. Prospective photographs in Case V showing mandibular prognathism.

3. Prognathism

Protrusion of the mandible and mandibular curvature causing so-called "open-bite," form definite types of deformity. In prognathism there is an overgrowth of the mandible in relation to the upper jaw. (Fig. 17.) In "open-bite" the lower jaw may or may not be overdeveloped, but owing to its peculiar configuration there exists an abnormal space between the upper and lower teeth. (Fig. 18.)

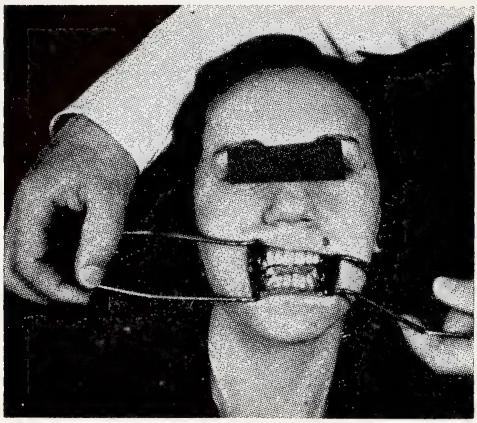


FIG. 18. "Open-bite." The contact of upper and lower teeth is limited to the last molars.

Mandibular prognathism may be due to hereditary causes, to trauma, or to disease. It is usually accentuated by mechanical factors such as pressure of the lip muscles and tongue or the teeth themselves. In supporting the inheritance factor as an etiologic cause, we see these conditions prevalent in different members of the same family, and it seems to exist more frequently in some races than in others. Many patients, of course, report for treatment with the family history perfectly negative. Blair and Ivy believe that atavism may be the primary factor in such cases. Trauma and disease are responsible for certain types of prognathism and "open-bite." These occur often in children suffering from severe contractures of the neck from old burns. Patients with extensive hemangioma involving the lower half of the face and cheek and tongue often show marked

prognathism. This may be due either to abnormal blood supply to the part or to the excessive size of the tongue or to a combination of the two factors.

Malunion following fractures of the jaw may lead to destruction of the normal occlusion of the teeth and "open-bite." Acromegaly is a well known cause, but these cases by themselves do not present problems for reconstructive surgery.

In most cases of mandibular prognathism there is a corresponding underdevelopment of the maxilla which in turn emphasizes the deformity. The upper and lower teeth often have poor contact and it is possible that the abnormal occlusion and plane of the individual teeth gradually displace the lower jaw and accentuate the deformity.

TREATMENT. — A mild degree of protuberance of the mandible is susceptible to orthodontic treatment if the condition is detected early. However, extensive cases are definitely surgical problems.

One of the great teachers of orthodontia (Angle) first advocated a surgical approach in this type of case in 1898. Since then operations for shortening the mandible have been performed with increasing frequency. A number of operative procedures have been advanced but only two types deserve our attention. One method first employed by Blair[6] consists of removing a section of bone from each side of the body of the mandible; the anterior segment is then pushed back into the new position and immobilized. The second method, advanced by Babcock[7] in 1910, was to cut through the rami above the level of the mandibular canals and to push the mandible back to a desirable position and immobilize it.

The relative merits of these two operative procedures depend first on the type of deformity; second, on the condition of the lower teeth; third, on the relative positions of the dental arches; and finally, fourth, on the facilities for postoperative immobilization of the mandible. My experience with these cases leads me to make the following observations: cross sectioning of the ramus is a simpler operative procedure than the approach through the body of the jaw. Similarly, healing processes seem to be more uneventful when the oral cavity is not penetrated. I have had two cases in

which chronic suppuration persisted for a long time when operation through the body of the mandible was performed. In fact, in one case owing to ineffective methods of immobilization, nonunion took place which demanded correction later by transplantation of bone. However, I have found certain drawbacks in making a cross section through the ramus. Three cases operated through the ramus tended gradually to show "open-bite." The first, however, a young man of 25, made an uneventful recovery finally with excellent functional and cosmetic results. Two other patients who had protrusion as well as "open-bite" were successfully operated on but in spite of all efforts could not be prevented from gradually redeveloping opening of the bite. These observations lead me to think that in such operations the upward pull of the masseter and internal pterygoid muscles must be respected. Therefore, in cases with open-bite with unfavorable means of immobilization, and with underdevelopment

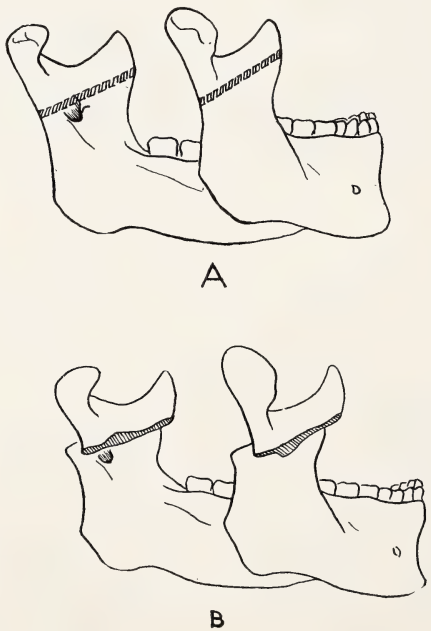


FIG. 19. Diagram showing the correct location and direction of the cut through the ramus. When the mandible is pushed back there invariably is an overlapping of the two sections.

of the maxilla, causing interlocking of the upper and lower teeth, operation through the body of the mandible is to be preferred.

In general there are two types of operative approach for cross sectioning the ramus (Fig. 19): (1) the closed method, and (2) the open method.

The closed method consists of passing a Gigli saw with a directing instrument along the inner surface of the ramus above the lingula, through two small openings in front of the ear and below the zygoma and cutting the bone with the saw.

In the open method the operative approach is through an incision about 1½ inches long at the posterior border of the angle of the mandible. The anterior surface of the ascending ramus is exposed and cutting is performed by a surgical burr under direct vision. My preference is for the second method as a safer procedure. The external scar is invariably inconspicuous. (See Case Report IV.)

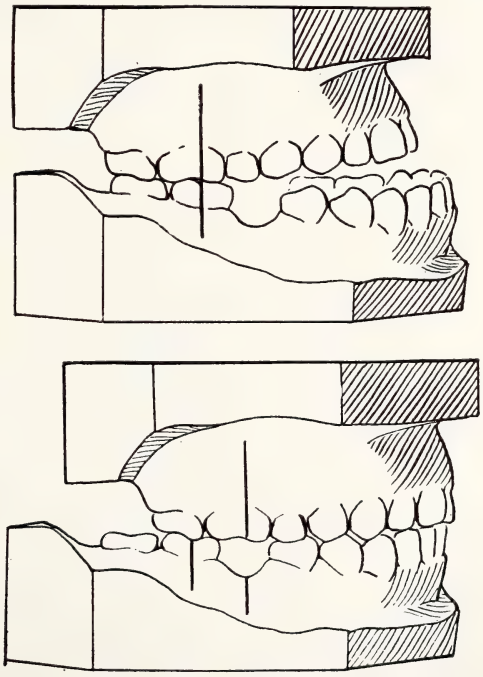


FIG. 20. Diagram showing the method of measuring the size of section of bone to be removed. (From Kazanjian, in *Internat. . Orthodontia,* 22:259, 1936.)

Operating through the body of the mandible is the most direct method of sectioning the mandible. Incisions are made on the inner and outer gingival borders of the mandible in the first molar region. The periosteum is separated from the bone, and an external incision is made to connect with the inner incision and provide a good exposure of the bone. With the Gigli saw a measured section of bone is removed. The same procedure is then carried out on the opposite side. (Fig. 20.)

Study models are essential when operating through the body of the mandible to determine the ideal location for removing a section and to determine the width of mandible that it is necessary to resect. They also help to decide which teeth should be extracted. The extent of resection needed is usually quite different in the opposite sides of the jaw. (Fig. 21.) Splints for immediate postoperative use are constructed before the operation. These are made in an adjustable form since absolutely accurate resection is difficult to attain.

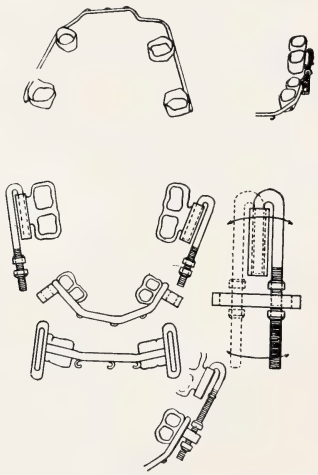


FIG. 21. Diagram of splint. (See text.) (From Kazanjian, in *Internat. J. Orthodontia,* 22:259, 1936.)

The splints in the diagram (Fig. 21) are (A) a retention splint fastened to the maxillary teeth and (B) a mandibular splint in three sections. Bands are fitted over the posterior teeth on each side of the mandible and a horizontal tube is soldered to the buccal surfaces

of these bands. (See B.) The anterior section of the mandibular splint is made with bands and a stout wire. A vertical slot is soldered at each extremity of this splint. (See B.) The three splints are converted into a single splint after the jaw resection by two hooked wires. The hooked end of each wire fits into the horizontal round tube and the anterior end of the wire is threaded so that it can be fixed in position, after coming through the vertical slot. (See B.) The amount of thread and the vertical slot allow any necessary adjustments. Intermaxillary elastics are used to fix the jaws together postoperatively, in addition to this mandibular splinting.

Besides the above types of deformity there are many others that are hard to put under a definite classification. Congenital absence of the ramus is a rare deformity of which I have seen four cases, three of them being under treatment.

The effect of contracted scars on the neck and chin upon growing bone is quite marked and causes deformities which are not uniform in character. Figure 23 shows, for instance, a marked forward bending of the alveolar process with definite undergrowth of symphysis menti. In this case the operative procedure in addition to correction of the defects of the soft tissues was to cut through the alveolar process below the apices of the roots of the teeth and to put it back in a new position.

CASE 5. — L. S., male, aged 20. This patient (Fig. 17) was first seen July 19, 1937. He had an extreme prognathism of the lower jaw. Arrangements were made with his dentist to make bands for the teeth which would be used as postoperative splints. It was decided in this case to operate through both ascending rami.

The operation was performed December 14, 1937, under local anesthesia. An incision was made just above the lobe of the right ear down along the jaw line for about 1½ inches. Through this wound and by blunt dissection it was possible to expose the lower pole of the parotid gland and the masseter muscle. The deepest portion of the masseter muscle was split and a fair exposure of the mandible was obtained. The ascending ramus of the mandible was visualized up as far as the sigmoid notch. The exposure of the ramus was subperiosteal. The mandible was then cut by repeated drill holes with the surgical burr about 1 or 1.5 cm. below the sigmoid notch. When this fracture was complete, the identical operation was carried out on the opposite side. The direction of the cut was obliquely downward and

backward above the point of entrance of the mandibular nerve and vessels into the mandibular canal. Both wounds were then packed with gauze, and then splinting and wiring of the mouth and jaws were carried out in order to set the teeth in their new occlusal relationship. It was possible to reduce the prognathism of the jaw about 1 cm. and to attain a correct occlusion. The teeth were secured in this position by intermaxillary wiring. Sterile gowns and gloves were readopted and each of the face wounds was then resutured in layers, a rubber dam drain in each case leading down to the fracture site. It was detected before closure of the wounds that in addition to the lower fragment of the mandible being pushed back there was an overlapping laterally of the mandible, the lower part carrying over onto the left side. The lower fragment on the right side was deeper to the condylar fragment and was thrust up and to a certain extent medially, and overriding it. (Fig. 19B.) Pressure dressing was applied in the usual manner.

The patient was discharged from the hospital on December 30, 1937. Two postoperative difficulties were encountered in this case. First, it became apparent that a good deal of pull had developed on the incisors. Both jaws had been wired together postoperatively and apparently some sort of fulcrum action and muscle pull had caused this condition. A good deal of tension developed in the incisor area, temporarily loosening the upper middle incisors. The second difficulty was that it took the patient several weeks after the mandible was liberated, before he could open his mouth normally wide. The final result was good. (Fig. 22.)

CASE 6. — W. F. a contracture of the neck from the age of 6 following extensive burns. Figure 23 shows the extent of soft tissue contraction of the neck, chin and lower lip, also the marked forward displacement and bending of the lower alveolar process carrying the anterior teeth.

Operation was performed for the correction of the external deformity by

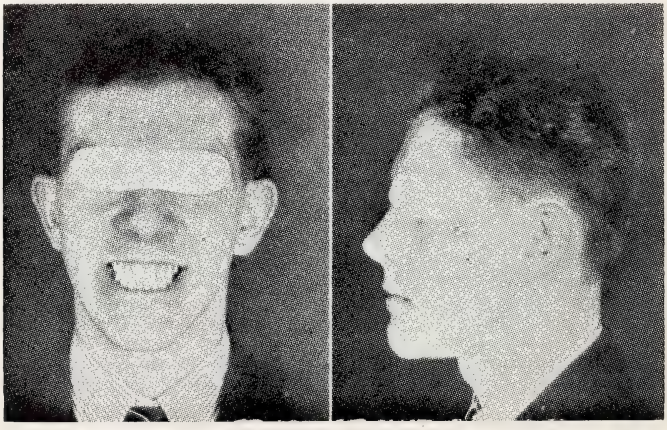
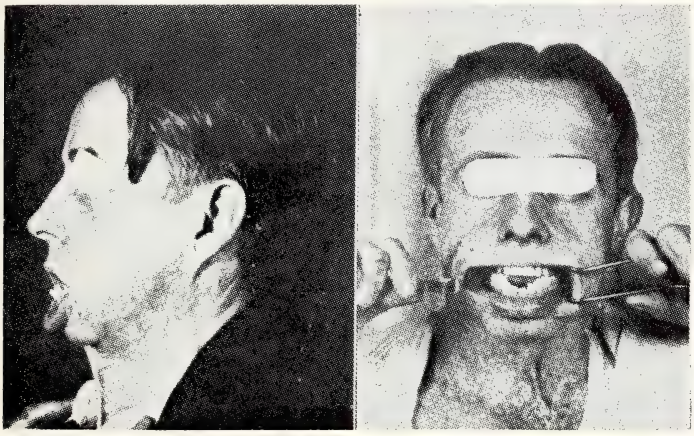


FIG. 22. Case V, postoperative photographs.

utilizing delayed flaps from the back of the neck and the transplantation of a free skin graft. The last operation was performed on November 29, 1937, under novocaine anesthesia. The canine tooth on either side of the lower jaw was extracted and the mucosa cut down vertically on either aspect of the mandible. Submucously a tunnel was made from vertical incision to vertical incision across the bony surface of the symphysis below the level of the apices of the incisors. With a small stiff saw it was then possible to saw through most of the mandible and with the chisel the resection was completed, leaving a rectangular piece of symphysial mandible free, except for the mucous membrane attached to it on either side. This fragment was bent into a more nearly normal position and seemed to fit its new site fairly accurately. It was wired in this new alveolar position. Hemorrhage was



A B

FIG. 23. Case VI, preoperative photographs.

A B

FIG. 24. Case VI, postoperative photographs.

under control and an external bandage was used about the chin and head to mobilize the jaw.

The patient was discharged from the hospital December 8, 1937, with a completely satisfactory result. (Fig. 24.)

CASE 7. — S. F. I first saw this patient, a white woman, age 20, in 1936. She had marked prognathism of the lower jaw with very poor occlusion of the teeth. (Fig. 25.) The maxilla seemed to be contracted. The contact

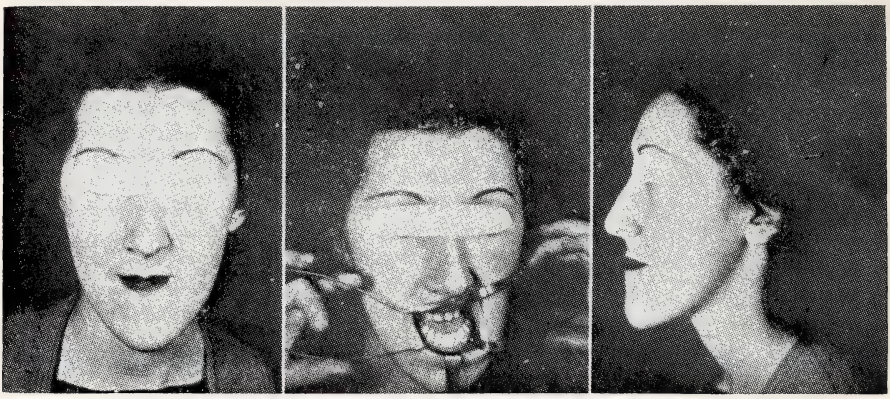


FIG. 25. Case VII, preoperative photographs.

of the upper and lower teeth was limited to the last molar region. She had already lost the first molars and second bicuspids on each side of the lower jaw. Splints were prepared at the Harvard Dental Clinic similar to the type in Figure 21. The patient was operated on at the Massachusetts Eye and Ear Infirmary February 20, 1937.

Under avertin and ether anesthesia, an incision was made along the superior margin of the gum line of the lower jaw from the bicuspid to the second molar tooth. This was carried down to the bone. The periosteum and mucous membrane were dissected free from the lateral surface of the mandible. An external incision about 2 mm. long was made along the jaw line of the mandible. A section of mandible 8 mm. wide was removed with the Gigli saw. The fragments of the lower jaw were then fixed by the use of wires which were bound onto the dental appliances previously prepared. The same procedure was carried out on the left side with the removal of about 16 mm. of the mandible. The upper and lower jaws were then partially fixed by the use of rubber bands.

Rubber dam drains were placed in each external incision and the mucous membrane wounds were closed with catgut sutures. The skin wounds were closed with interrupted kaldermic sutures.

There was considerable discharge from the external incisions. The right side healed in a few days. The left side discharged for almost two months although the *x-ray* showed no evidence of bone infection.

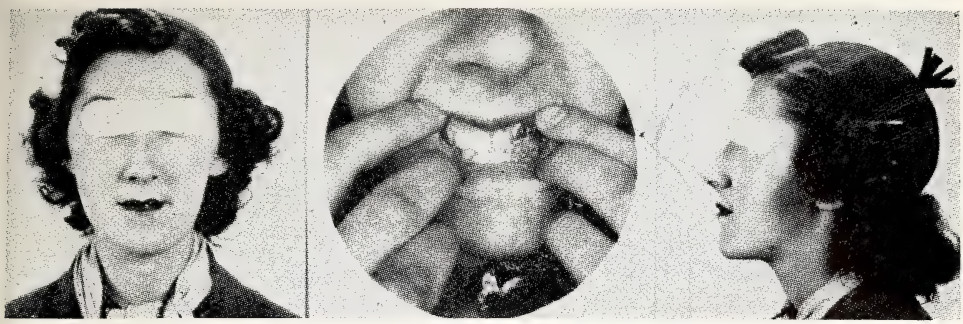


FIG. 26. Case VII, postoperative photographs.

The patient was discharged to the Out-Patient Department and on July 1, 1937, complete consolidation was found to be present. (Fig. 26.)

Summary

The major deformities of the mandible can be classified under three distinct groups:

1. Those in which there is loss of bone with the continuity of the mandible definitely disturbed.
2. Those in which there is maldevelopment and retrusion of the mandible.
3. Those in which there is overdevelopment of the mandible.
3. Those in which there is overdevelopment of the mandible, such as occurs in prognathism and "open-bite."

The main causes of loss of bone in the mandible are osteomyelitis, trauma (especially gun-shot wounds), and surgical intervention for the removal of growths. The general outline of treatment consists of transplantation of bone and the construction of prosthetic appliances. Transplantation of bone is the desirable procedure whenever it is considered practical. The writer prefers osteoperiosteal grafts, even in large defects.

Prosthetic restorations have a definite place in the restorative treatment of the mandible. Their main function is to hold the remaining segment of the mandible in normal position, in order that the existing teeth may perform their masticating duties.

Symmetrical bilateral retrusion of the mandible may be due to

birth injury, trauma, infection involving both sides of the mandible, or bilateral ankylosis at an early age. The treatment consists of advancing the anterior part of the lower jaw by making a diagonal or L-shaped incision on each side of the mandible.

Asymmetrical retrusion of the mandible shows the chin markedly retracted and one side of the mandible shorter than the other. The correction of such deformities involves lengthening the short side of the mandible, supplemented by transplantation of bone or cartilage to obtain prominence of the chin.

Prognathism of the mandible and "open-bite" form a definite type of deformity. Prognathism is treated by two methods. First, by the removal of a measured section of bone from each side of the body of the mandible and pushing it back into its new position; or second, by cutting through the ramus and holding the entire lower jaw in the new position. The relative merits of these two methods are discussed in detail. Previous to operation, it is necessary to make preparations in the form of measurements and dental splints, or postoperative treatment in the form of orthodontic work or other dental treatment may be required.

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NURSING IN PLASTIC SURGERY AND MAXILLO-FACIAL INJURIES

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There is no essential difference between the nursing of maxillo-facial injuries and the general surgical nursing of the wounded. Yet many of the surgical manœuvres involved in plastic surgery seem strange to the young nurse, and it is an undoubted fact that many nurses fail to look after these cases adequately, because they are afraid to upset the surgeon's programme. It is therefore important that the nurse should have a clear idea of what the process involves, and the steps by which reconstruction is attempted.

Nurses who are attracted by this work become enthusiasts, for they are able to see the fruits of their own exertions growing before their eyes. But there are also many who have no aptitude for this branch of surgery, and consequently no desire to acquire the necessary skill.

The main features of plastic surgery and the treatment of maxillo-facial injuries may now be described in broad outline.

The Immediate Care of Injuries

A common civilian injury — cuts, abrasions, and crush fractures — will usually have been dealt with by the surgeon before the case is handed over to the nurse, but in the absence of the medical man much can be done with safety and great advantage to the patient.

For example, a bleeding wound can be washed and packed with hot normal saline, and then repacked several times until it is quite clean. Finally, it should be packed with ribbon gauze soaked in such substances as saline, paraffin, flavine emulsion, flavine, or White-

head's varnish. The latter is particularly useful on injuries to the mucous membrane. Holding the wound together by strapping over the packing is an excellent method of maintaining pressure. If the wound is dry it may be cleansed, lightly packed, and drawn together.

In crush fractures of the face, the broken nose should be left to the doctor to replace, but the nurse should at once apply iced Pond's extract or lead lotion compresses to check bleeding and prevent the development of hæmatoma. If the jaw is broken, special care must be taken at once to look for completely loose teeth or detached pieces of bone; these should be gently picked out of the mouth. Small plugs can be improvised to fit into bleeding hollow spaces in the jaw. Bone wax or chewing-gum or dental stent can be used as plugs.

Support of a Broken Mandible

Never use the four-tailed bandage as a jaw support, except in dislocation of the temporo-mandibular joint. The Burrell sling bandage is an excellent method (see *The Nursing Times,* 14th October, 1939). Elastoplast, pulling in an upward direction and attached to the temporal regions, is most efficient. The hairy temple on both sides should first be shaved so as to get a firm attachment for the upward pull; between the zygoma and the mandible the sticky surface of the elastoplast should be folded on itself so that it does not become adherent to the skin in that region. The plaster adheres again under the chin and the border of the mandible.

In gunshot injuries of the jaw, where there is gross displacement of the fragments and the tongue tends to fall back, the nurse should pull the fragments forward and upward into apposition with the upper jaw. This will drag the base of the tongue forward and tend to check bleeding. In very serious bleeding the nurse should insert her fingers behind the tongue and press it against the jaw. Blood should be removed from the back of the throat by a sucker or a swab.

Crush Fractures of the Maxilla

When a portion of the maxilla is lying loose on the tongue, an attempt should be made to replace it by the finger; it can be supported subsequently by manual methods.

In all cases of jaw fracture — whether upper or lower — the dental surgeon will be called in by the surgical officer in charge.

Position of the Patient

Whenever the tongue tends to fall backwards, turn the patient over, or, if he is in a sitting position, hang the head down. He must not be on his back on a stretcher. When he is properly placed the tongue will come forward, and blood will flow out of the mouth and so prevent choking.

Nursing after Operations

The position of the patient is as described in the previous paragraph, but it is usual for the nurse to be in charge of either an artificial airway or a tongue suture to assist the process. After operations on the palate, the patient should be turned forward with his head hanging over the edge of the bed so that he can get rid of secretions from the back of his mouth.

The problems of posture after a pedicle flap has been made — particularly where the arm is conveying a flap to the face — are very considerable. It has always been a source of irritation to surgeons that very little advance has been made in the way of mechanical supports. In the meantime, reliance must be placed on elastoplast fixation assisted by good and intelligent nursing. The nurse should be instructed by the surgeon as to the exact position to be maintained when the patient returns to bed after operation, and the variations of that position which are permissible within the limits of safety.

The distance between the two points of attachment must be kept neither too tight nor loose enough to allow kinking. Some relief to the patient's irksome position can often be obtained by moving

the arm and the head *together* into a new position. As the days go on greater latitude is allowed. During the whole time that the arm is up to the head, massage should be applied occasionally over aching joints, and such movements as are possible should be carried out. It will often be helpful to the patient to give him a mirror; in this way he can himself move within safe limits.

Feeding Patients who have Jaw Fractures

Liquid diet is usually necessary. A feeding-cup with a long rubber spout should be used. Even when many teeth are present and the upper and lower jaws are fixed together by the dental surgeon, it should be possible to find a way in somehow. I have never known a patient starve for this reason. After the feed, as well as at other times, mechanical cleansing of the mouth is necessary. The open wound should be syringed frequently with a Higginson's syringe, using mild peroxide and saline or some other suitable mouth wash.

Infection Haematoma and Failing Blood Supply

The nurse should always keep the surgeon informed of the patient's temperature; a rise in temperature is an almost certain guide to the onset of an infected hæmatoma or a general infection. She should keep a close watch for redness around the stitches, especially if it is associated with swelling or inflammation. Treatment must be immediate. Frequent warm (110° F.) hypertonic saline solutions should be applied as fomentations; probably 12 per cent. sodium sulphate is the best of these solutions.

Hæmatomata are very liable to occur in plastic operations on account of the huge surfaces exposed and the smallness of the vessels involved. Dressings should be examined from time to time to see that undue swelling has not occurred. When hæmatoma develops, the stitches should be removed (if the surgeon has given permission) and a sinus forceps gently inserted into the hæmatoma, which is gently and persistently expressed.

Early evacuation is of great importance. Re-apply pressure, if

that is permissible, to try to prevent an evacuated hæmatoma from recurring. This is difficult when a flap is in process of being grafted, because the very pressure of the hæmatoma will probably damage the blood supply. If the blood supply shows signs of weakening, as evidenced by failure to get a return of the blush after gentle pressure, the nurse should at once notify the surgeon. In any case warm saline should be applied without delay.

When a drainage tube has been inserted (*e.g.* in the hip region when a bone graft has been taken) see that it is draining, or try to make it do so.

Removal of Sutures

See that your scissors are fine, and sharp right to the point. They must be of the sharp-pointed type. If you can cut the one loop of the stitch without having to lift the stitch by the force of cutting, this is the ideal procedure. It is facilitated by holding the scissors parallel with the loop and not at right angles to its line. Sometimes, however, it is essential to lift the stitch in order to display one edge of the loop. The stitch must never be cut through both sides of the loop, leaving a piece of the material in the tissues. Both before and after removal the stitches should be painted with spirit. They should be kept clear of clots with the aid of warm saline, and any crusts that form can be teased or pushed off the stitches without hurting the patient. After cutting the loop, lay the open scissors flat upon the skin with a blade on either side of the wound, so that, when the slight pull comes, the edges of the wound are not separated.

Subcuticular stitches require a special technique: one end is cut as short as possible and the other end wound round a pair of forceps. The skin is then massaged over the stitch rather than the stitch pulled out of the skin. This is a process akin to pulling a "lost band" out of the top of a pair of pyjama trousers.

In handling continuous sutures every other loop may be cut, and the intact loop between the cuts will lift two in a single action.

The Removal of Dressings

When the dressings are caked hard and adherent to stitch ends, one frequently sees nurses (and doctors too) seizing the dressing and pulling it off rather roughly. This should not be done. A great deal of kindness as well as efficiency can be shown by inserting the point of a pair of dissecting forceps between the skin and the dressings and allowing the spring of the forceps to wheedle off the dressing. This requires patience and time, but it is well worth while and should be the standard method.

After-Care of Raw Areas

The raw area left by raising a flap is sometimes grafted immediately, or it may be left raw. In the latter event it is usually covered with some greasy dressing such as tulle gras, or paraffin and flavine. This dressing may stay on for two to three days; it should be fomented with saline or peroxide before it is removed. The wound should then be thoroughly cleaned and dabbed, and the crusts removed before a new dressing is applied. Frequently the dressing is changed in a day or two to warm salines alternating with eusol packs before returning to a greasy dressing such as tulle gras. For exuberant granulations, firm pressure, a spirit dressing, or frequent salines are useful.

The After-Care of Free Skin Grafts

The fixation of the pressure carried out at the operation must not be altered. The patient is not allowed to lie on the dressing, or to use any pressure that might disturb it. When the pressure is removed, small places that have not "taken" are dabbed with 20 per cent. mercurochrome. Very gentle oil massage with the finger on the new graft may be required. From about the twelfth day onwards the pressure is gradually increased.

Accidental pressure may occur through a bandage slipping off the corner of a pedicle flap, interfering with the proper blood supply of its extremity. This is most likely to happen in a forehead flap rhinoplasty.

To obtain support for a flap to keep it on its new site, paint the surface of the flap with mastisol, and that of the skin beyond the stitches. Then stretch lightly a piece of lastonet between the two patches of mastisol when they have become "tacky."

Many patients suffering from conditions requiring plastic surgery are very seriously depressed. They can be materially helped by the quiet confidence of the nurse in the surgeon's ability to produce a satisfactory result in the long run. Often the process appears hopeless to both patient and nurse; on these occasions — particularly after a flap has failed to take hold or has undergone partial necrosis — the nurse's cheerful and straightforward confidence will materially affect the final result.

RECONSTRUCTIVE OTOPLASTY

By PAUL W. GREELEY, A.B., M.D.
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Complete or partial reconstruction of the external ear has long been one of the major problems in plastic surgery. The chief stumbling block in rebuilding a new ear lies with the problem of furnishing an adequate support to the overlying skin. The numerous curves and levels of the normal ear cartilage making replacement of this tissue an important undertaking.

Prior to the following procedure the best attempt toward supplying a supporting framework consisted in the utilization of costal cartilage or a bone graft from the iliac crest that was shaped to represent the missing ear cartilage. Obviously neither source gave adequate material from which one could carve a structure that would closely represent the normal auricle, regardless of how adept the operator was as a sculptor. The most one could accomplish was to give the patient a poorly shaped rim or helix. The net result of such operative procedures was always disappointing, both to the operator and patient. Pierce,[1] Padgett,[2] and Kirkham[3] have revived the utilization of carved costal cartilage and, while their results are superior to those of their predecessors, several finer points are still lacking.

The use of any foreign material, whether it be metal, ivory celluloid, or the like, is only to be mentioned because of the failures that result. Such material is not tolerated and like all foreign bodies is sooner or later extruded.

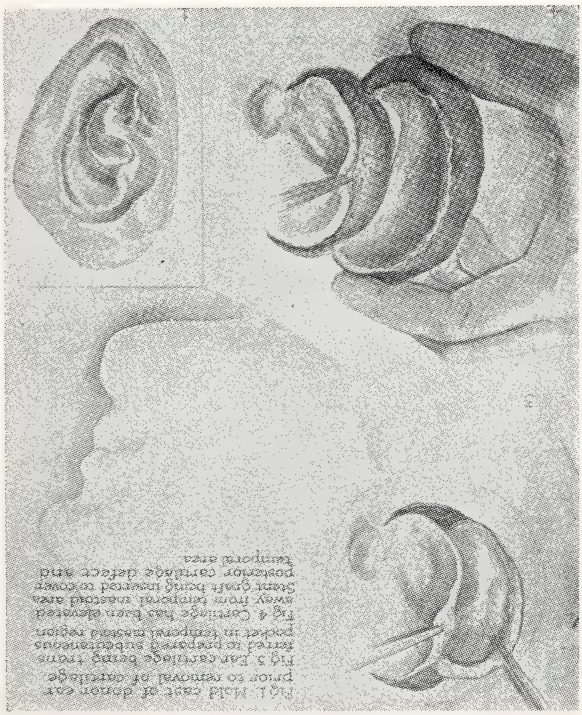
Before discussing plastic reconstruction it should be recalled that there appear to be only two tissues that can be successfuly transplanted from one individual to another, namely cornea and cartilage. The success of transplant of these two tissues apparently is depend-

ent upon the fact that neither has a blood supply and that they are kept alive by absorbing nutriment from adjacent soft tissues.

With the above in mind, we have been following the method recently devised by Gillies,[4] where an ear cartilage taken from another individual is used. The donor has always been and should always be a woman, who can cover the donor ear with her hair.

Since external ear defects commonly occur in children, the patient's mother is usually chosen as the cartilage donor. There is no special reason for choosing the mother except that she is invariably willing to do this for her child and thus the availability of an ear cartilage becomes more simplified.

After preliminary surgical preparation, an impression of the donor's ear is first cast with warm, sterile dental modeling compound (Fig. 1). When hard it is removed and temporarily laid to one side.



FIGS. 1, 3, and 4.

To remove the cartilage, an incision is made along the posterior rim of the helix, exposing either all of the cartilage or whatever part is needed. The skin is then dissected from the anterior and posterior aspects of the cartilage, during which time careful attention is paid not to fracture the cartilage or perforate the skin during the process. After being completely freed, it can now be removed easily. The incision in the donor's ear is then sutured. The previously prepared mold (Fig. 1) is again placed upon the anterior aspect of the ear and secured by bandaging under moderate pressure. This procedure insures accurate coaptation of the two skin flaps. Although one may expect to have the completely unsupported ear tend to droop or shrivel, it is surprising how rigid they sometimes become due to the formation of a firm scar between the anterior and posterior skin coverings (Fig. 2). However, should any deformity occur, the donor can easily disguise this with her hair. The sacrifice is not, however, nearly as mutilating as one might suspect.

A curved incision corresponding to the normal anatomical location of the helix is now made through the hairless skin overlying the temporal and mastoid areas of the recipient. The skin is mobilized by freely undermining in all directions. After completing

FIG. 2. Donor ear showing healed state after removal of cartilage.

hemostasis the ear cartilage is then passed through this incision and placed in a normal anatomical position, following which the skin wound is closed (Fig. 3). Pressure is then made over the newly placed cartilage with a moist sterile marine sponge, held in place by bandaging. Small bits of the sponge may be cut out to fill in accurately all the underlying depressions to insure adequate adherence to each of the various ridges and concavities.

In three to ten weeks it will be noted that the mastoid skin is firmly adherent tc the anterior aspect of the newly transplanted cartilage. At this time the original incision may be reopened around the rim of the cartilage, leaving a broad pedicle attached anteriorly. The entire mass is then lifted forward until it stands as a normal ear, matching its fellow on the opposite side. There now exists what appears to be a normal ear from in front, but with a skin defect overlying the mastoid process and on the posterior aspect of the cartilage. This area is now covered by a Stent graft.

A piece of sterile warm pliable dental modeling compound is next pressed into shape to fit the defect behind the ear and mastoid process. After this has been permitted to harden, it is removed and covered with one single thick split-skin graft; that is, one large enough to cover both the mastoid and posterior cartilage defects.

Fig. 5. Fig. 6.

Figs. 5. and 6. Results of illustrated case. Existing primary skin tab has been rotated downward to become new lobule.

This graft is then spread over the mold with the raw surface outward, following which it is reinserted into the defect behind the ear (Fig. 4) and is secured in place by a pressure bandage. Approximately one week later the bandage is reopened, the Stent mold removed, and the excess graft trimmed away. An ear of normal appearance is now observed, the transplanted cartilage being lined on the anterior aspect by the former mastoid skin and on the posterior side and mastoid process by newly grafted skin (Fig. 6).

For reconstructing partial losses, obvious modifications of the steps described may be carried out.

In congenital defects there is frequently a small tab of skin that can be swung downward to become the new ear lobule. If this is absent, a small tube pedicle flap raised nearby will furnish sufficient skin for this purpose.

The question has been raised as to what is the better time in which to reconstruct these congenital defects. As with other congenital disorders the results on the whole are usually best when done at the earliest age that the child will stand operation and cooperate. While the surgical problem is easier during the teens, from the psychological standpoint it is wiser to have this defect repaired before the child becomes too conscious of his abnormality; that is, before school age. We are not certain to date whether this ear will grow at the same rate as the normal ear, but it apparently remains at approximately the same size so that, even though the ear may be slightly larger at first, it will eventually match the one on the other side.

The average layman (and doctor) always asks about the question of reconstruction of the external auditory canal when this is absent due to cogenital anomaly. We very definitely feel that this should not be attempted unless coincidental deafness exists. This operation is difficult to perform and is apt to be unsuccessful even though the canal has been re-established, because of the problem of maintaing its patency. From the practical standpoint these children seem to hear as well from use of their normal ear, thus making this surgery unnecessary. In other words, we are dealing chiefly with a cosmetic

problem; the functional aspect is ordinarily but of secondary importance.

In conclusion, the following thought should be remembered. Many physicians see individuals who have just lost all or part of an ear in an accident. If the lost portion is completely detached, suturing it in place holds very little promise of success even if done immediately after the accident. On the other hand, this portion should never be discarded, but the cartilage should be saved for future reconstruction. If it is not feasible to bury it under the mastoid skin at once, it may be sutured into a subcutaneous pocket in the abdominal wall until one is prepared to place it in its permanent location.

Summary

An operative procedure as recently developed by Gillies for the permanent replacement of the external ear has been described and found to be uniformly superior to previous methods. The operation utilizes an ear cartilage taken from another individual as the basis of the reconstruction. Such an architectural form gives far better cosmetic results than former operative procedures.

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SOME ASPECTS OF THE PROBLEM OF AMPUTATION STUMPS IN RELATION TO LIMB FITTING

By R. LANGDALE KELHAM
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1. Amputation Sites

Whilst a good Limb Maker can make and fit an artificial limb to any stump the surgeon may provide, the experience of the limb organization of the British Ministry of Pensions over the past 22 years, in the handling of over 45,000 amputation cases, has proved that a stump of a certain length, amputated whenever possible in the manner to be described, is one which is long-lived and gives no further trouble to the patient during his limb wearing life under the most arduous conditions.

The tendency to standardisation of sites and methods is based upon this experience coupled with the need for producing, when possible, a trouble free stump at the outset, in recognition of the fact that the most pressing thought in the mind of the recent amputee, is the question as to whether his stump will last without recourse to further surgical interference and whether he will, when fitted, be able to return to his old or some new and useful occupation.

The surgeon, in acting up to these requisites will not only be serving the best interests of the patient, but also be complying with the requirements of the Limb Maker, though the latter has, owing to improvements in design, manufacture and fitting ability, become of very secondary importance. In other words, the stumps which have been proved to be, surgically, the best happen to be also the best from the fitter's point of view.

Though a long stump can be shortened whilst, with two exceptions, a short stump cannot be lengthened, no good purpose is served by the conserving of bone and tissue known to be valueless

unless, at the time of emergency amputation, sepsis is to be feared rendering reamputation at a later date inevitable.

The old view that the longer the stump the better for limb wearing purposes, no longer holds good either for surgical or prosthetic purposes.

Shorter stumps, in fact, are known to be less liable to breakdown and, in the case of thigh and leg cases, permit of limbs being fitted which allow of a better and more natural gait and appearance than it is possible to achieve with limbs fitted to the long femur or transcondylar amputation.

The following amputation sites and methods are recommended on the assumption that the amputation is one of deliberation, not an emergency in the presence of sepsis, and that subsequent re-amputations are not envisaged: these being adhered to in all British Ministry of Pensions Hospitals and elsewhere in Britain.

Upper Extremity

(a) *Amputations above the elbow.* The ideal stump is one, measuring from 8 to 9 inches from the tip of the Acromion, but never exceeding 9 inches. The shortest stump which can be made to function with an artificial arm is one which provides not less than one inch of functional stump, measured from the upper border of the anterior axillary fold. In those cases in which it is feared that it will be impossible to provide this inch, the functional value and length can sometimes be improved by severence of the fibres of pectoralis major.

The method of amputation for all arm amputations should be by the equal anterior and posterior flap method, or the circular method. The scar must be terminal; an adherent scar in these cases is not necessarily detrimental, since these stumps are not weight bearing.

(b) *Amputations below the elbow.* The ideal length, measured from the olecranon is 6 to 7 inches but not exceeding 7 inches. Compared with this stump, the through-wrist amputation is of no prosthetic advantage. The shortest forearm stump which has real

functional value measures 3½ inches from the olecranon. If this amount cannot be provided, an ideal above elbow stump is the best. Flaps as described in (a) above.

(c) *Mutilations of the hand.* The retention of any portion of the hand, provided that portion be pain free and of normal sensitivity is of greater value than amputation at the ideal site.

Lower Extremity

(a) *Above the knee.* Length 10 to 12 inches, measured from the tip of the great trochanter, but not exceeding 12 inches.

The anterior flap method is the best giving a transverse posterior scar where it is free from friction or traction. The flap should be rounded off and not squared or rectangular in order to obviate the formation of "dog's ears": it should contain only connective tissue. The muscles should be cut at, or just below the level of bone section and be allowed to retract: the sewing of muscles over the bone end is not necessary.

The most painfree stump is one in which the sciatic nerve was not seen at time of muscle section. Traction upon it or crushing and injection of alcohol are contraindicated. The securing of haemostasis and prevention of haematoma formation is of the greatest importance. In clean cases drainage is not necessary.

The decision as to whether a very short stump will, ultimately, have to be fitted with an ordinary above knee limb or a Tilting Table limb (in which later the stump is immobilised at 90 degrees in the socket) depends upon the functional, rather than the actual, length of the remaining femur stump below the ischial tuberosity when the stump is dependent.

A Tilting Table may be avoided if the stump is poorly covered, thin and conical with no redundant tissue. When a Tilting Table limb is inevitable, the retention, when possible, of the head, neck, and great trochanter, to the level of the lesser trochanter is of greater value than disarticulation.

(b) *Below the knee.* The ideal length of tibia, measured from the inner articular head is 5½ inches—but not exceeding 6 inches.

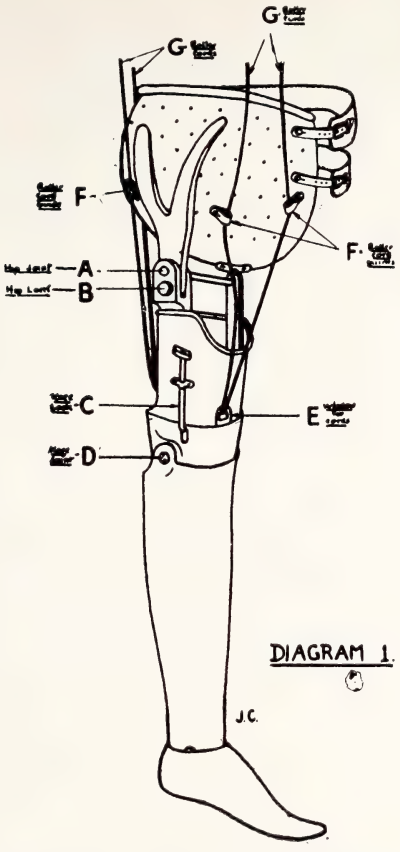


DIAGRAM 1.

The equal anterior and posterior flap method is the best, or a slightly longer anterior flap. The equilateral flap method provides a most unsatisfactory stump in comparison with the above and should be avoided.

The fibula should be cut one inch shorter than the tibia to avoid cross union and the resultant elimination of the spring action of the former. Total excision of the fibula is not recommended. The anterior extremity of the tibia should be bevelled off to avoid friction between the overlying skin and the sharp bony edge with consequent ulceration and perforation.

The shortest tibia fittable with a below knee limb is determined by the absence of bulk and redundancy of tissues. A poorly covered

stump having but 2½ inches of tibia can be fitted with a below knee type of leg.

The incidence of circulatory disturbance and breakdown of stumps over 6 inches long is in direct proportion to the amount by which the stump exceeds that length as is also the difficulty of providing a perfect cosmetic result with an artificial leg; this latter is of great importance when dealing with women patients.

2. The Preparation of the Patient for Limb Wearing

The psychological approach to the recent amputee by those in contact with him has a most important bearing upon his ultimate success as a limb wearer. This applies even more forcibly, however, to arm amputees than to leg cases. The mental shock and resultant despondency to which all who lose limbs are liable requires counteracting by all those in attendance upon him. This can be achieved by encouragement and the instilling of hope and the conviction in the patient's mind that "all is not lost". The sight of others similarly disabled, making successful use of their artificial limbs is of the greatest value. An ounce of encouragement is worth more than a pound of sympathy.

Hence the desirability of concentrating, as much as possible, the handling of amputations in special hospitals rather than distributing them amongst many. This is of benefit, not only to the patient but to the staffs, enabling the latter to study and come to understand better the mental outlook and problems of the amputee.

3. The Preparation of the Stump for Limb Wearing

(a) *Arm stumps.* When the stump has healed and stitches have been removed (1) active exercises to the proximal joint should be commenced. (2) the stump should be bandaged in accordance with a method described in detail under (b) (1) below. In clean cases-healing by first intention, it is essential that the fitting of an artificial arm be commenced at the earliest possible moment, about one month from date of amputation, otherwise the patient will, through accustoming himself to the use of the remaining hand,

lose all desire to persevere with an artificial arm when he receives one. The stump not being weight bearing suffers no harm from early application of the limb.

(b) *Above knee stumps.* On return to the ward after amputation, no sandbag or pillow should be placed beneath the stump; its presence merely produces flexion deformity. After the removal of stitches, the patient should be encouraged to commence active stump exercises, particular attention being given to the re-education of the adductors and extensors. For the latter, the patient should lie prone on the bed, place his hands locked behind his neck and raise the head and shoulders from the pillow a number of times a day.

No massage should be applied to the stump at any time.

Stump bandaging should now be commenced.

A new method of bandaging stumps in preparation for limb wearing has been developed at Roehampton which has proved to be of the greatest value in reducing oedema rapidly and shaping up the stump for subsequent limb fitting.

It is of value in that it can be commenced immediately after the stump has soundly healed; its reducing effects appear at once whilst a plaster pylon used for the same purpose cannot or should not be supplied till the stump is ready for the first limb. The rate of reduction, as proved by comparative checks over a large number of cases, is much greater than that achieved by the use of a pylon, and, therefore, limb fitting can commence earlier. The success of this method depends, however, entirely upon meticulous attention to the following points.

(a) The use of two crepe bandages, 6 inches wide, sewn together end to end. For below knee cases, 4 inches wide.

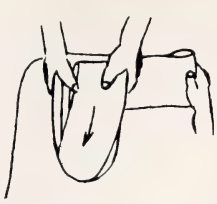
(b) The rolling of the joined bandages in extreme tension.

(c) The application of the bandage in the prescribed manner.

(d) Its reapplication four times a day (on rising in the morning, mid-day, at 4 p.m., and on retiring to bed at night).

(b) (1) *Method of application.* The free end of the bandage is placed on the anterior aspect of the stump at the level of

Diag 2.

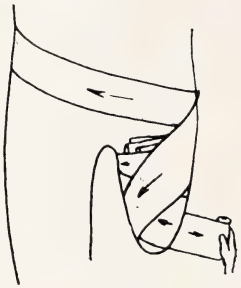


Diag 3.

Diag 4

Diag 5.

Diag 6.



Diag 7.

Diag 8.

Poupart's ligament and held there by the patient's thumbs. Draw the bandage down in great tension over the anterior surface and extremity of the stump and up to the gluteal fold on the posterior aspect, where it is held by the patient's forefingers. The second movement brings the bandage downwards and slightly obliquely to enclose the tissues at the inner lateral extremity of the stump in tension, and thence up to the original starting point on the anterior aspect where it is again held by the patient's thumbs. The third movement brings the bandage down anteriorly and slightly obliquely to enclose firmly the tissues at the outer lateral extremity, and passes up to the gluteal fold where it is held by the thumbs. A couple of turns are taken around the upper part of the stump, but not too firmly, being in sufficient tension only, to hold the upper extremities of the bandage in order to release the patient's hands.

The bandage is now carried to the extremities where tension is

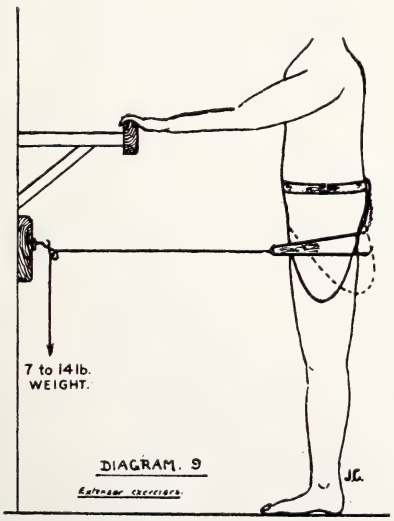
again applied in order to compress the lateral tissues and thence up the stump, evenly, with slackening tension right up to the perineum; thence, from within outwards two spica turns around the waist and return to the stump's extremity with increasing tension and finish off.

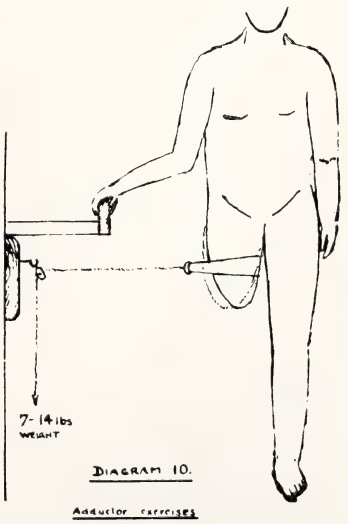
Care must be taken that the cross-over of the spica turns be placed externally and not over the anterior aspect of the stump; should the cross-over be anterior, a flexion deformity will result.

Frequent checks should be made every two days or so, of the stump circumferences, at perineal level, mid stump and two inches above the extremity, and recorded. If the bandage is being correctly applied, the shrinkage rate will be greatest at the lower measurement.

Stump muscle re-education. As soon as the patient can use crutches, he commences exercises in the physio-therapy department. It is of advantage if a number of patients perform these at the same time in that the competitive spirit is introduced. Small pulley wheels are fixed to the wall of the room, three feet apart and three feet above the ground.

A sling, made of webbing or canvas, four inches wide at the back





and tapering to the front, shaped as illustrated, is passed over the stump; to the front of the sling is attached a piece of cord 9 feet long, which passes over the pulley wheel and to its free end is tied a sandbag or bag of shot weighing 7 lbs. to commence with. As the exercises proceed, a weight of 21 lbs. may be used. The patient standing erect, supports himself against a rail so placed that the bag is just off the ground with the stump dependent. Facing the rail, extensor exercises are practised and then, turning sideways to the wall, adductor exercises.

If continued twice a day for a week, these exercises will tone up the muscles ready for limb wearing.

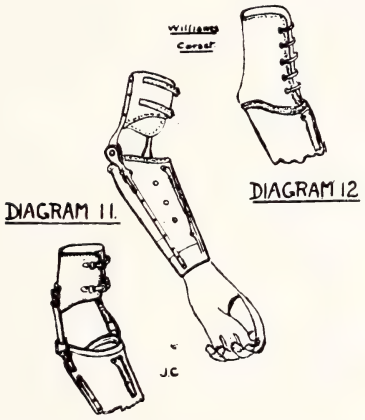
(b) (2) *Amputations below the knee.* In order to prevent flexion deformity at the knee, the use of a back splint for several hours daily whilst the patient is in bed, is advisable. Quadriceps exercises should be practised as soon as possible after the stump is healed. Bandaging with two 4 inch crepe bandages should commence early —the method of application being on the same general lines as already suggested in (b) (1) above, except that the bandaging is terminated just above the femoral condyles and should leave the patella exposed to permit of knee movements being practised.

Some special points to which a thigh amputation should pay attention when commencing to use a limb are concerned with the need for adduction of the limb when making a forward movement of flexion. The first pace should be taken with the sound leg, a short pace, and the artificial limb then brought just in front of the sound foot. As the artificial heel touches the ground, the stump must be extended against the back of the socket in order to cause and maintain extension of the artificial shin on the knee. By use of the adductor muscles, the circumducted gait is obviated. It is essential for good walking that at the earliest moment the patient be taught to balance his whole body weight upon the artificial limb, with the sound foot off the ground; this further develops the adductor and abductor muscles of the hip and obviates the tendency for the patient to dwell longer on the sound leg at each step which results in a limping gait.

(Note.—The bandaging of arm stumps, using one 4 inch crepe bandage is carried out on the same general principles as already described; for below elbow amputations the elbow joint is left exposed as for below knee bandaging).

4. A Few Points Regarding the Fittings of Limbs

(a) *Artificial Arms.* Limbs for very short upper arm stumps should have the upper extremity of the sockets well blocked, moulded and carried over the shoulder to the acromion process. For very short forearm cases, though many methods of limb suspension are quoted, only two have proved really successful. One is by an upper-arm corset attached to jointed side steels with an elbow lock, and the other is by the "Williams Corset" method as illustrated.



The latter method, though giving a very secure fixation, tends to limit flexion at the elbow in some cases.

(b) *Artificial Legs.*

(1) Limbs for thigh amputations. All are fitted to carry the body weight entirely upon the ischial tuberosity; end bearing has not been used for many years. The socket of the metal limb is so aligned on the thigh portion of the limb that a flexion of about 2½ degrees is allowed for in all cases as a routine. This, it is found, is of great benefit to the wearer, even when there be no

flexion deformity, owing to lack of pressure upon the stump in which the ilio-psoas is usually overacting when the stump is at rest.

Sockets for longer and fat thigh stumps are more circular in shape, but for poorly covered or shrunken stumps they are triangular; the base of the triangle being represented by the perineal border. It has been found to be essential that that portion of the socket abutting against the adductor tendons be channeled out in the form of the groove from above downwards. Since putting this into practice as a routine in all cases, it has been noted that furunculosis or sebaceous adenomata in the adductor region of thigh stumps, once so common, has become a rarity.

It is now found possible to fit all young and active thigh amputees

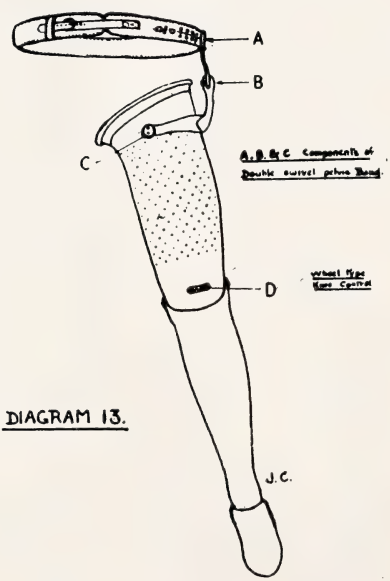


DIAGRAM 13.

DIAGRAM 14.

with limbs, in such a manner that when standing erect the anterior superior pelvic spines are level, instead of being lower on the amputated side. In addition, it is found that pelvic suspension by such means as the double swivel pelvic band is used for the majority of cases, the central knee control, or shoulder control method being reserved for older patients, those less physically sound, or those living in very hilly or rough districts.

The fact that more attention is now paid to stump muscle re-education is undoubtedly responsible for these changes in practice.

(2) Below knee limbs are, for the majority, fitted in such a way that the weight is borne upon the ischial tuberosity or upon the thigh, this method having largely superseded the tibial bearing method. The life of these stumps has been prolonged thereby and breakdowns rendered extremely unlikely with the result that they stand up to the heaviest working conditions. The introduction of "polycentric" knee joints a few years ago has been of the greatest

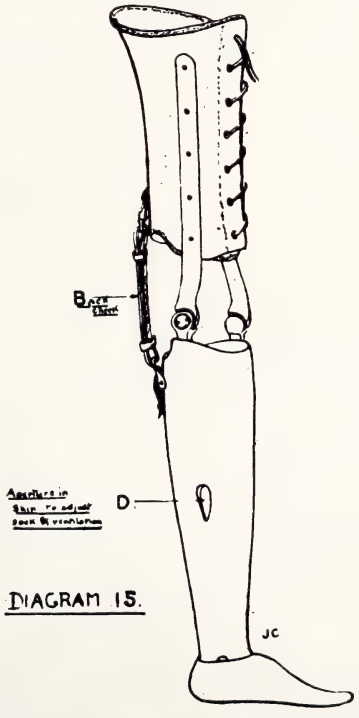


DIAGRAM 15.

benefit to the below knee limb wearer, in that the joints action corresponds more closely to that of the natural knee joint. Greater ease of walking is permitted together with greater flexion and less friction to the stump. It has been noted that cases exhibiting the usual three well marked bursae have, after fitting with polycentric joints, entirely cleared up and the bursae have never recurred.

5. The Supply of Artificial Limbs to Women and Children

The fitting of limbs to these classes of cases presents problems peculiar to them, but lack of space prevents this important aspect of limb fitting being referred to in any but the most general terms.

It is the custom to fit children with fully articulated limbs from the age of 3½ upwards. *For psychological and other reasons,* peg legs are never prescribed. The shins of these limbs are made on the telescopic principle with the result that the cost of alteration and lengthening is reduced to the utmost. Apart from this, the general principles of fitting adults apply equally to children. Artificial arms are issued as for adults, but there can be no standardisation of

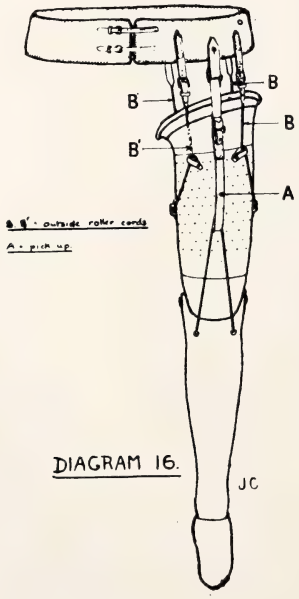


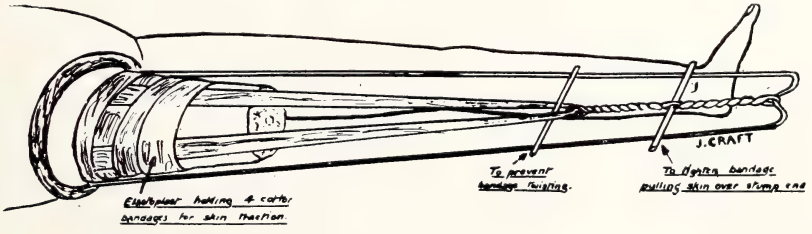
DIAGRAM 16.

parts. With regard to women amputees, the same principles apply as for men except that for both above and below knee cases a thigh or muscle bearing is provided rather than an ischial bearing; no form of shoulder suspension is used, waist-belt suspension having no metal parts being universal.

Women arm amputees appear to be more adaptable than men and their success as arm wearers is remarkable. It is customary for them to engage in full household duties with an artificial arm and are able, also, to knit and do crotchet work.

6. Guillotine Amputation

This method of amputation has, of necessity, to be employed in a certain proportion of cases. There appears to be an impression in the minds of some, firstly, that the limb fitter dislikes having to fit these cases, and secondly, that a guillotine stump requires re-amputation before a limb can satisfactorily be fitted to it. With regard to the latter, experience has shown that if conditions permit of adequate skin traction being employed from the time of operation, reamputation will not be necessary in order to fit a limb. When, therefore, skin traction can be employed and continued without interruption, it can be assumed that reamputation will be avoided.



SKIN TRACTION in GUILLOTINE AMPUTATIONS.

DIAGRAM 17.

I am indebted to my colleague, Dr. A. J. Craft (Limb Surgeon), for his illustrations.

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THE AFTER-CARE OF AMPUTATIONS

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Rehabilitation following the loss of an arm or a leg can never be complete, but it is doubtful if the degree of success that is possible is generally appreciated. The man with an artificial limb who climbs a mountain or flies a plane is duly lauded but considered exceptional, whereas feats of as great prowess are not unusual, but pass unnoticed on account of their unspectacular manner of execution. Only those who deal with many amputations realize the number of labourers who are able to compete with their more fortunate fellows, in spite of the loss of an arm or a leg. It is also believed that the percentage of amputations returning to almost full activity is capable of a considerable increase, not through the adoption of new methods, but through the more efficient application of principles already known. In short, a more decided policy of cooperation and coordination is required.

Preparation for the Artificial Limb

The modern prosthesis, which has been developed in the light of experience following the last war, is a highly efficient piece of mechanism, and for its best use a certain type of stump is required. New or unorthodox stumps should not be provided except after the closest collaboration with the limb maker. The surgeon who adopts the attitude that he can provide a new type of stump and leave the artificial limb to be designed subsequently, not only fails in his duty to his patient, but shows at the same time a decided lack of appreciation of the fundamental problems concerned. Improvement in the design of stump and prosthesis must go hand in hand. Only recently has the necessity of collaboration been fully realized. So often in the past the aim of the surgeon has not gone beyond

removal of the limb and supervision of healing. The patient was allowed, indeed often encouraged, to play a passive part for months, and when finally fitted with his limb any difficulties encountered in its use were regarded as unavoidable. The limb maker was often unjustly blamed for failures which were due to inadequate after-care, and entirely beyond his control.

An amputation stump cannot be judged until the patient has returned to activity wearing his prosthesis. Because of inadequate after-care, many otherwise excellent stumps give a poor performance when fitted to the artificial limb. Moderately good stumps will often give excellent service if well looked after in the postoperative period. Bad stumps can usually be improved by a secondary operation.

The after-care of the stump, which begins when the last suture has been inserted at operation and ends when the patient returns to work wearing his prosthesis, should be under the direction of the surgeon who performs the amputation. In many instances this ideal will prove impossible to attain, but the patient must on no account be discharged from the care of a surgeon, who, acting in conjunction with the limb-fitter, will continue supervision throughout this period. If the patient is allowed to vegetate at home for several months without supervision the stump may not be bandaged or, worse still, may be incorrectly bandaged. Fixed flexion deformity may occur at the knee or hip, and muscles controlling the stump will become wasted. The mental attitude of the individual who has suffered, or is about to suffer, an amputation, is important and is often overlooked. Some patients seem hardly affected by the experience, whereas others, if neglected, fall into an apathetic state from which they can be roused only with difficulty. For this reason it is desirable to stimulate interest in future activity at the earliest possible moment. When the amputation is not performed as an emergency, the surgeon should see the limb-fitter with the patient before operation, to discuss the proposed stump and prosthesis. This consultation makes the patient realize that more interest is being taken in his future activity than in the immediate disablement of the operation. Such consultations are also helpful to the surgeon in deciding upon

the exact type of stump required, for unless he has the necessary leisure and interest, his knowledge of the technical details and improvements in relation to artificial limbs will be incomplete.

Segregation of the limbless patients offers many advantages. In special hospitals dealing with large numbers of amputations, the mental outlook of the patient is superior to that encountered in general hospitals. The spirit of emulation is readily inspired, and routine after-care, in the ward and physiotherapy department, is easily established. The limb-fitting centre can, and should be attached to the hospital, making for unified control and ease of collaboration between departments.

Pylons and Calipers. — In uncomplicated cases, in which healing has been by primary intention, every effort should be made to get the patient fitted with an artificial limb two and a half to three months after amputation. Early readjustment is easier than late, for every increase in this period makes the patient more conscious of the fact that he is a limbless man.

The practice of fitting plaster pylons and patten-ended calipers to amputations of the lower extremity was good in this respect, but the disadvantages have since been found greatly to outweigh the advantages. One of the objects of the plaster pylon was to harden and shrink the stump, yet in many instances it served only to irritate nerve endings which had not recovered from the trauma of operation, and to produce an undesirable shape of stump. A correctly applied bandage is more effective in shrinking the stump, and heavy massage, pummelling, or the wearing of a pylon in the early stages, does not make the stump harder but more sensitive. A stump which is not ready to take an accurately made artificial limb is even less ready for a roughly made appliance, such as a pylon.

Nerve Pain. — Amputations for severe or chronic bone sepsis may heal perfectly, but it is usually found that these cases take a little longer before the stump will bear the pressure of the artificial limb. A mild neuritis is present, which may take the form of pain in the stump when subjected to pressure, or pain in the toes or

fingers which have been removed — the so-called "phantom limb." All patients experience the phenomenon of phantom limb following amputation, but as a rule do not complain of symptoms after the first week. The severity of pain varies directly with the amount of sepsis in relation to cut or lacerated nerves. Thus, an infected hæmatoma may be responsible for greater post-operative nerve pain than a chronic osteomyelitis of the tibia which is limited by the periosteum.

The upper extremity, being better provided with sensory nerve endings, may suffer more severely, and if inefficiently treated at the beginning the pain becomes fixed centrally and persists long after the peripheral neuritis has subsided. In some instances this pain has permanently prevented the wearing of an artificial limb; in others it has been cured by forcing the patient to wear a correctly fitting prosthesis, proving beyond doubt its central origin.

Operative Technique. — If the surgeon in charge of after-care and limb-fitting has not performed the amputation, it is desirable that he should be in possession of certain facts regarding the operation. Localized tender spots over nerve endings and persistent complaints of phantom limb, after the first week or two, may be due to stretching, crushing, or ligature of nerve trunks at operation. Injection of alcohol and other substances, once thought to prevent painful nerve-bulb formation, has now been shown to have the opposite effect. The phantom limb which all patients experience at some time does not give rise to complaints unless there is some definite cause for nerve irritation. A bulbous-ended stump which is found difficult to reduce may be caused by suturing the muscles over the bone end and, in patients with any tendency to sepsis, a persistent sinus may often be traced to a piece of catgut which requires removal.

If it is known that nerves have ben ligatured or muscles sutured, it will be wise to allow an extra month or more before the artificial limb is worn. This time, although precious, is well spent on account of the subsequent trouble which will be avoided.

The Ideal Stump

The ideal stump is firm and free from tenderness with well-developed muscles and full joint movements. It tapers gradually to the end, and without any loose skin that can be picked up between the fingers. The scars are not adherent, and are situated away from points of pressure. Although the basis of all these desirable qualities is laid at operation, each one can be banished or enhanced by the after-care provided. The stump may be made tender by misdirected massage, the end of the stump may be made bulbous by incorrect bandaging, and failure to see that joint movement remains full may result in loss of extension; without proper exercising muscles become wasted.

In the production of the ideal stump, after-care may be divided into four stages: —

(1) The initial dressing.
(2) Post-operative care in the ward.
(3) Bandaging and exercises in the physiotherapy department.
(4) Limb-fitting and instruction in walking by the limb-fitter.

The *initial dressing,* following amputation, is important, as tissues at the area of cross section, which become relatively fixed within a few days, are easily arranged to give the desired contour to the stump. The mid-thigh amputation, for example, is usually dressed with gauze and wool, on top of which is applied a bandage. The chief concern is not the shape of the stump, but a secure dressing which will not slip off in bed. Theoretically, a spica bandage with the firmest turns at the end of the stump, will give the desired result; in practice, this causes the stump to be extruded from the gauze and wool like a tightly grasped orange pip. The usual post-operative dressing is secure because it constricts near the groin. Two effects must follow: a bulbous end to the stump and an obstructed venous return. The first may be overcome by intensive bandaging in the later stages; the second greatly assists in the production of a hæmatoma which has permanently spoiled many an otherwise perfect stump. A post-operative dressing of elastic adhesive bandage applied longitudinally as in Fig. 1, is the only method which moulds the

tissues, and cannot possibly constrict the venous return. Three strips of bandage are used: the first is applied at right angles to the suture line and stretched well upon each side of the stump: the second and third steps are applied obliquely to control lateral bulging of the skin flaps. A circular turn of bandage applied round the very end of the stump assists in the final moulding of tissues. I have no experience of plaster of Paris as a post-operative dressing and, although it may give equally good results in expert hands, it would appear that the use of such a dressing is not entirely devoid of risk.

Post-operative care in the ward consists largely in preventing the adoption of a bad attitude. Ward staff, unless otherwise instructed, will almost certainly place the amputated leg stump on a pillow, and so encourage flexion deformity. In the complicated case, in which healing is delayed, this deformity will become permanent and necessitate a more complicated type of prosthesis. Exercising is not usually desirable in the healing stage and, unless complications develop, the dressing is left undisturbed for ten days, when the sutures are removed. An elastic crêpe bandage is now applied over a small gauze dressing, if necessary, and the patient sent to the

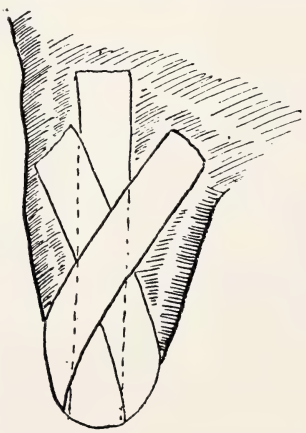

FIG. 1. Post-operative dressing of elastic adhesive bandage used for amputation stumps. The dressing presents a similar appearance when viewed from the back. The final turn of bandage around the end has been omitted for the sake of clarity.

physiotherapy department for exercises and bandaging as soon as the stump is soundly healed and capable of standing a firm bandage without pain.

About this time the first visit to the limb-fitting centre will be necessary so that primary measurements for the artificial limb can be taken. The type of prosthesis which will be supplied is best decided by the surgeon and limb-fitter in consultation, if this has not already been done. Surgical and prosthetic considerations must be weighed together. Usually the artificial limb cannot be supplied in less than six weeks, and during this time bandaging and exercising are carried out daily. During this time also, the limb-fitter will see the patient at weekly or fortnightly intervals, to measure shrinkage and report on any folds of flesh which may require special attention.

Finally, when the artificial limb is fitted, the surgeon and limb-fitter will discuss the cause of any discomfort or defects in gait and how they may be remedied.

BANDAGING. — The shrunken bony stump will stand more hard use than will the well-covered fleshy stump, because extra tissue, particularly at the end of the stump, leads to increased friction. Power has to be transmitted from the bone to the socket of the prosthesis through yielding soft tissues. In a fleshy stump the bone must travel a relatively greater distance before the tissues are compressed enough to move the artificial limb. This internal friction is often the main cause of nerve pain in fleshy stumps. External friction between skin and socket is also more pronounced in a well-covered stump, and abrasion of the skin or intertrigo between folds of skin is commonly encountered. One of the main responsibilities of those in charge of after-care is therefore to secure maximum shrinkage before the artificial limb is fitted. Amputations through the thigh are the most difficult stumps to deal with in this respect, and the method of bandaging which has been found most effective will be described in detail. Other amputations do not present any great difficulty, provided it is always borne in mind that all loose tissue should be bandaged away from the end of the stump. No

stump is ready for the artificial limb until the smallest circumferential measurement is at the end.

For bandaging amputations above the knee, two 6-inch wide crêpe bandages are advised, and for convenience they should be sewn end to end and made into a single roll. Three turns of the bandage are first taken over the stump end and held by the patient (Fig. 2A and 2B), who pulls strongly while the stump is bandaged

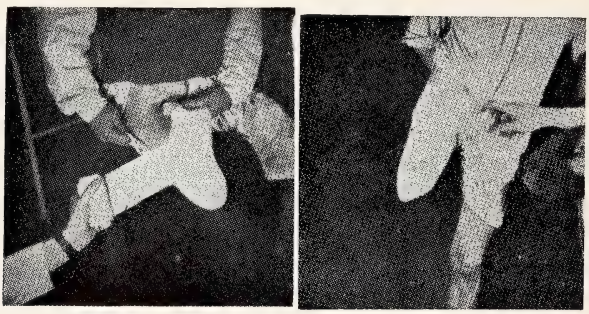

FIG. 2A FIG. 2B

FIG. 2. (A) Method of bandaging to shrink stump before the artificial limb is fitted. Note how patient assists by pulling on the initial turns of bandage. (B) Completed stump bandage.

in a circular manner from below upwards, with the firmest turns at the end. When the top of the stump is reached, the bandage is completed as a spica around the waist and, if evenly applied, the stump then presents a gradual tapering outline without bulges or depressions. A stump sock pulled over the bandage and pinned to the shirt helps to keep it in place and exert a little more pressure. Re-application of the bandage three or four times a day is necessary to secure rapid shrinking. A through-thigh amputation will often show as much as three inches reduction in the terminal circumference after three weeks correct bandaging.

Amputations below the knee should not have the action of the quadriceps impaired by carrying the bandage above the upper margin of the patella. A single 4-inch bandage is sufficient for this and all other stumps.

Preservation of Joint Movements and Muscle Power

Fixed flexion deformity at the hip or knee is not uncommonly encountered when amputations of the lower extremity are sent for limb-fitting. Allowance for this deformity must be made by fitting the stump socket at an angle which permits the line of the artificial leg to be directly beneath the patient when standing. If this were not done, in the case of amputation through the high, the artificial knee-joint could not be fully extended into the stable position, and any weight borne would cause the knee-piece to shoot forward. The ultimate result, even with the corrected prosthesis, is inferior and, when the flexed stump is long, the amount of space required for correction makes the limb unsightly.

To prevent this disability, *above-knee amputation stumps* should be kept extended, with sandbags and a towel, for a few days. When the patient is able to sit up, daily inspection is necessary to ensure that extension at the hip remains full. The vicious habit of resting the stump on a pillow must be broken. It is still frequently encountered where least expected.

Below-knee amputations are best kept on a straight metal gutter-splint until the wound is healed. Wool padding is used over the elastic adhesive dressing, and any tightness of the bandage, which might obstruct the venous return, is carefully avoided. An exception to the general rule of complete rest, until the stump is healed and free from pain, may be made with benefit in the case of amputations below the knee. Contraction of the quadriceps, without removing the splint, may be started at the end of the first week. This prevents wasting of the quadriceps and, as the knee is fully extended, disturbance of the operation area cannot happen.

Abduction as well as flexion deformity is also encountered in amputations through the thigh, but the deformity is rarely fixed and results only from a weakness of the adductor muscles. This weakness allows the artificial leg when fitted to wander away from the midline. Now, it must be remembered that amputation through the thigh, at any level above the adductor tubercle, removes part of the adductor muscles without affecting the abductors inserted into

the great trochanter. Contraction of the remaining adductors is inhibited during the healing period, as any attempt at adduction causes pain by pulling on recently severed tissues at the stump end. The unimpaired abductors acting against an abridged and inhibited adductor group invariably cause abduction, in the post-operative period, unless measures are taken to prevent it. Naturally the shorter the stump, the greater the tendency to abduction. With efficient after-care this adductor weakness is no disadvantage in stumps as short as nine inches, measured from the tip of the great trochanter. Shorter stumps and stumps with poor power of adduction require a rigid pelvic band fitted to the prosthesis, which allows for the movements of flexion and extension only. Alternatively the stump may be set at an angle in the socket so as to bring the artificial limb into correct alignment. If the abduction deformity occurs in a long stump, its correction means either an unsightly prosthesis or a limitation of the useful movements of abduction and adduction.

To prevent weakness of the adductor muscles, daily exercises are given against resistance, as soon as the stump is healed and free from pain. No benefit is derived from starting exercises earlier than this, but the stump should not be allowed to lie in the abducted position during healing. This results in retraction of the already weakened adductors and further loss of power.

No special attention to the posture of *arm stumps* is necessary during healing, and the consequences of slight loss of elbow or shoulder movement is not so serious as a similar loss in the lower extremity.

Exercising. — Active exercising of the stump is started as soon as the wound is healed and free from tenderness. In uncomplicated cases this will usually be about three weeks after amputation. All joints of the stump are put through a full range of supervised active movements for short periods daily. Overtiring of the stump and the production of pain are to be avoided at all stages. Passive stretching will not be necessary if post-operative care has been adequate, but if any deformity has been allowed to develop it may succeed in

overcoming slight degrees of hip or knee flexion. Movements at first will not be done against resistance, but later on, as muscle tone improves, the exerciser depicted in Fig. 3 is of great assistance in promoting further development. Where amputations below the knee are concerned special attention should be directed to the quadriceps. In the case of amputations through the thigh, the adductors and extensors of the hip-joint are the most important muscle groups.

Stumps Which Should Not Be Fitted With an Artificial Limb

Generally speaking, there are four so-called ideal sites for major amputation of the extremities. Below the knee, five and a half to six inches, measured from the joint line, provides a stump of ideal length. Above the knee, ten to twelve inches, measured from the tip of the great trochanter, or a good hand's breadth above the adductor tubercle, is the length of choice. Amputations through the forearm, six and a half inches below the tip of the olecranon, and through the upper arm eight inches below the tip of the acromion, with the arm by the side, are the most satisfactory arm stumps. For reasons given on page 376, it will be the duty of the surgeon directing after-care to advise, and in certain cases persuade, the patient to have a re-amputation before the limb is fitted, if the length of the stump greatly exceeds these figures. If this policy

FIG. 3. Stump exerciser of broad elastic sling and elastic cord, used for developing muscles in the later stages before the prosthesis is fitted. In this case the adductors, which are often neglected, are being exercised.

were more general, much subsequent pain, trouble, and expense would be spared, for a large percentage of late complications are directly caused by excessive length of stump. The long stump is inferior, because it does not stand up well to heavy use, and also in certain instances cannot be fitted with the best type of prosthesis.

An *amputation performed two inches above the knee* joint appears at first sight to have the advantage of greater power and control through longer leverage, but in practice this is discounted by the fact that the most efficient form of knee mechanism in the prosthesis requires three or four inches of space above the joint line, and cannot be accommodated. Instead, knee-joint mechanism has to be fitted on the outer aspect of the limb, or the whole joint dropped to a lower level than that of the sound limb.

In a varying period of from a few years to a decade, trophic disturbances make their appearance at the end of the stump. Pain, coldness, discoloration and swelling may be followed by ulceration, which finally necessitates re-amputation at an undesirably high level. The short stump never suffers in this respect. Re-amputation of the long stump before fitting is in the patient's best interest, for few, once fitted with a prosthesis, will consent to operation before it becomes imperative.

The *long amputation below the knee* suffers from similar trophic changes and, although the prosthesis is essentially the same as that for a shorter stump, there is no gain in function.

Fixed flexion deformity, when it occurs in the long leg stump, makes re-amputation all the more desirable, for the necessary tilting of the socket to bring the artificial leg into correct alignment makes the outline of the prosthesis unsightly. No difficulty in obtaining consent for operation is usually experienced when the subject is a woman, as there is no possibility of matching the prosthesis when a long stump above or below the knee has any degree of flexion deformity. Even the below-knee stump of more than seven inches, without deformity, requires a prosthesis noticeably larger than the normal calf.

Long arm stumps, above or below the elbow, suffer from the

same surgical and prosthetic disadvantages, although the onset of degenerative change in arm stumps does not occur so soon, on account of the freedom from weight bearing.

Other primary faults from which the amputation stump may suffer are usually concerned with the *scar* and *skin flaps*. Following amputation, a severe degree of sepsis, for instance, may result in the substitution of thin scar tissue for sound skin over the bone at the end of the stump. In the lower extremity it will often be obvious that this scar tissue will not stand the strain of wearing an artificial limb. On the other hand, arm stumps with similar scars may prove satisfactory on account of the absence of weight bearing. When weight is borne, some vertical movement of the stump within the socket of the artificial leg cannot be avoided, and this so-called piston action results in an increase of pressure within the terminal part of the stump. Terminal scars are therefore subject to a bursting effect which rapidly discovers any weakness. Re-amputation of leg stumps which have a thin terminal covering of scar tissue is advisable before the first prosthesis is fitted. Excessively loose folds of skin, which tend to overlap, should be excised. This relatively minor operation excludes the possibility of a troublesome intertrigo developing later, and improves the shape of the stump with benefit to the fitting and comfort of the artificial limb. The square contour of amputation stumps below the knee is often accentuated by the fibula which has been cut at the same level as the tibia. An inch or so of fibula removed when the skin flaps are being trimmed adds little to the operation and improves the stump considerably.

Scars otherwise sound but adherent to bone do not necessarily preclude the wearing of an artificial limb. Experience of amputations below the knee with an antero-inferior scar adherent to the tibia may indicate subsequent trouble, but in the average case with no other fault the artificial limb should be tried before further operation is advised. As with any other surgical operation, much of the success or failure depends on the patient. Stumps with grossly puckered and adherent scars have given excellent service when the folds of the skin have been kept powdered and the stump

sock changed regularly. Unfortunately, sweating of the stump is greater in the labourer than in the sedentary worker, who is more likely to change his stump sock daily and give adequate attention to cleanliness. Many late complications can be avoided if the stump is kept clean and dry and a fresh sock worn each day. The use of talc powder adds to comfort, and any slight irritation in the initial stages before the stump has become accustomed to the prosthesis may be allayed by treating the skin with a soda-free toilet soap. The soap should be well rubbed in until dry and the stump then powdered. Surgical spirit, apart from its present scarcity, has no advantages over soap in the treatment of skin irritation.

The Guillotine Amputation

The guillotine amputation, with all tissues sectioned at the same level, is inferior to any amputation performed with skin flaps. Healing is slow, and nerves, exposed to a mild terminal infection, may remain sensitive for some time after stump has healed. Terminal œdema also takes long to subside, so it is unusual for a guillotined limb to be fitted with the prosthesis before six months have elapsed. During this relatively long period, between amputation and limb-fitting, care is required to ensure that faulty posture does not lead to loss of joint movement. When the stump has healed, muscles will be more wasted and will require more attention, and skin traction, which must always be sustained throughout the healing period, tends to encourage terminal redundancy of tissue. Therefore, guillotine amputations of a length only sufficient for prosthetic requirements need considerably more attention to bandaging and exercising than do amputations performed by means of skin flaps, and the operation has often been condemned when inadequate after-care has been the sole cause of failure.

When possible, of course, the surgeon performing such an amputation will leave sufficient length of stump to enable a flap re-amputation to be done at a later stage, for the guillotine amputation is most commonly employed under conditions of stress, which do not always permit of the essential post-operative care required to

produce a sound stump. In connection with re-amputation, it is important to note that too early operation may activate latent sepsis, with disastrous results to the new stump. This tragedy can be avoided by allowing several weeks activity on crutches when the stump has healed, and the short break from hospital life which this allows is beneficial to patients who have suffered the long period of recumbency necessary for the healing of a guillotine amputation. It should be made quite clear to the patient, however, that another operation is necessary, or otherwise difficulty may be experienced in obtaining his consent at a later date.

Late Complications

Late complications are classified under three headings: —

(1) Arising from primary defects, such as excess tissue, unsound scars, damaged nerves and excessive length of stump.

(2) Neglect, on the part of the patient, to give reasonable attention to the stump and prosthesis.

(3) Simple breakdown from excessively heavy work.

Primary defects have already been dealt with, and it is enough to say that any stump which has had an inherent weakness from the beginning will always be prone to give trouble so long as treatment is purely conservative. Therefore, although it may be possible to heal an ulcerated area on a badly placed scar, it is better to remodel the flaps, if this can be done without sacrifice of essential length.

Neglect and stupidity take many forms, from an abhorrence of soap and water to amateur alteration of the prosthesis. Little can be done for the patient who refuses to take advice, but two troublesome conditions of the through-thigh amputation are worth mentioning. The first follows the use of too many stump socks. One or two socks are usually worn according to the fit of the socket, but if a patient who only requires one sock persists in wearing three or four, the stump is pushed out of the socket and a roll of flesh forms at the top. In time this fleshy ring becomes difficult to reduce and prevents the tuber ischii from bearing on the upper part of the socket. The second condition is a sebaceous adenitis of the adductor

region where the inner part of the rim of the socket rubs against the thigh. Patients with a sebaceous diathesis are usually affected, but lack of cleanliness and bad fitting encourage obstruction of the pores and retention of sebum. If the condition is allowed to progress, recurrent attacks of inflammation lead to a chronic condition characterized by numerous small scars interspersed by a few discharging points. The early case will often respond to a period of rest, and more careful toilet of the stump when the artificial leg is again worn. Chronic cases demand excision of the affected area of skin and subcutaneous tissue. With due care an excellent scar, which heals by primary intention, can be secured, and complaints of tenderness over the scar are rare when walking is resumed.

Severe nerve pains are rarely encountered without a primary defect, but occasionally they give rise to complaint in the more fleshy type of stump following unusually severe exercise. As mentioned before, the fleshy stump suffers more from internal friction, which is one of the causes of nerve irritation. Treatment of these cases of irritable stumps is often difficult. Three or four weeks of absolute rest in bed should be prescribed as a routine in severe cases. Following this, even if symptoms have not subsided, the patient should be tried with a correctly fitting prosthesis. Attention must be diverted from the disability and to this end, if a return to work is not possible, occupational therapy should be given. It was remarkable to notice how some of these patients recovered, in the first year of the present war, as well-paid work became available.

Arm amputations, apart from stumps with gross primary defects, hardly ever return with late complications, on account of the absence of weight bearing.

LEG LENGTHENING

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Unequal lower extremities have a twofold deleterious effect upon the patient — mechanical and cosmetic. The problem of correcting the disability has been in the minds of surgeons, and especially of orthopedists, for many years. Attempts to equalize the extremities have often been made through conservative means, i.e., building up the sole and heel of the shoe on the affected side.

A difference greater than three-quarters of an inch is often detected by the limp of the individual. And with greater differences the normal mechanics of the body are offset so that a vicious cycle is created. The shortened limb gets less and less physical strain in walking, as most of the weight and function is carried by the longer limb. As a result there is stimulation to the longer and further incentive to shortening of the other. Scoliosis, with resultant poor posture, is a common end result of inequality of the lower extremities. With these changes, there is a whole gamut of internal and somatic reactions from which patients seek relief.

In the victims of poliomyelitis such developments are more common and, of course, more severe because of the secondary muscular involvement — paresis to paralysis.

The muscle sense through a regular soled shoe is much more acute than through cork build-ups, especially where 2 or 3 inches of sole are necessary. Even in the poliomyelitics the mechanics of the entire body may be assisted through proper skeletal equalization. Especially is this true in flail knee cases. Such patients, with arthrodesed ankles, can lock their knees in extension when walking. One can dispense with braces with lock devices. A cork build-up of 2 or 3 inches, and in many cases less, will not permit such locking at the knee. The lever action of the foot is lost because of the built-up.

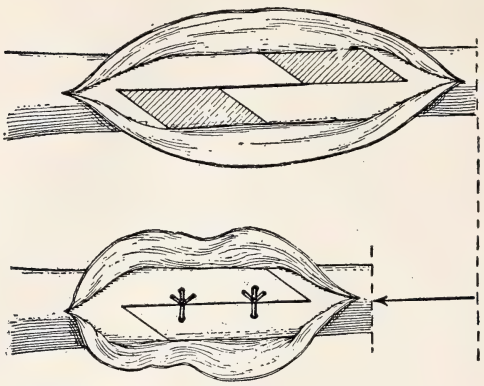

FIG. 1. Z-excision to shorten femur or other long bone, and kangaroo suture of fragments.

The public at large has not reached a stage in which it will readily accept the cork, leather and metal braced employee who is seeking work. Appearance counts for a great deal in obtaining the opportunity to demonstrate that one can do as well or better than the physically unhandicapped individual on the same job. It is therefore up to the surgeons to continue to perfect their techniques or accept those of others to obtain the more physiologic (skeletal) increase in length. Such lengthening will aid the job-seekers, where artificial soles can only hamper him.

Unfortunately, because of many factors—cumbersome apparatus, operative trauma and mismanaged postoperative convalescence, leg equalization by lengthening has been given up by many for leg shortening, a more simple operative procedure. This, however, should not decide the operation for the patient. An open operation carries a certain risk. A patient should be permitted to have one good leg to stand on. For that reason and for the more normal physiology obtained, the equalization should be obtained by lengthening in the affected side.

When one witnesses the surgery of femoral shortening by some of those who are giving up leg lengthening, one soon realizes the many mechanical shortcomings of this procedure. These surgeons remove a cylinder of femur and rely on only the cross-section contact

for union in the presence of marked resultant atonicity of the thigh muscles. It is no wonder that the convalescent period, with plaster and braces, extend over a year. Their argument that leg lengthening also carries a long convalescent period and that therefore the femoral shortening is more advisable, is not consistent. A Z-excision with kangaroo suture of the fragments would improve the technique

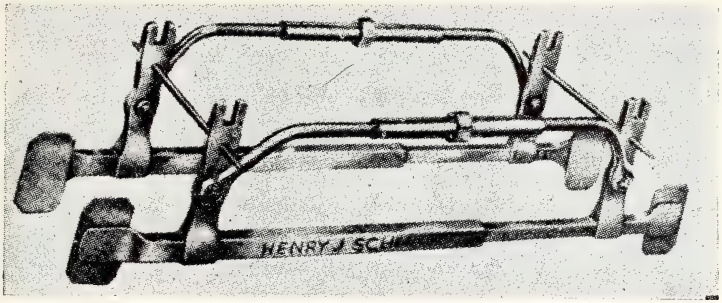

FIG. 2. Apparatus used for leg lengthening.

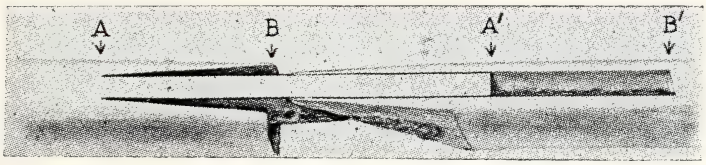

FIG. 3. Plastic osteotomy of tibia. AB equals A′B′. AA′ equals 2AB.

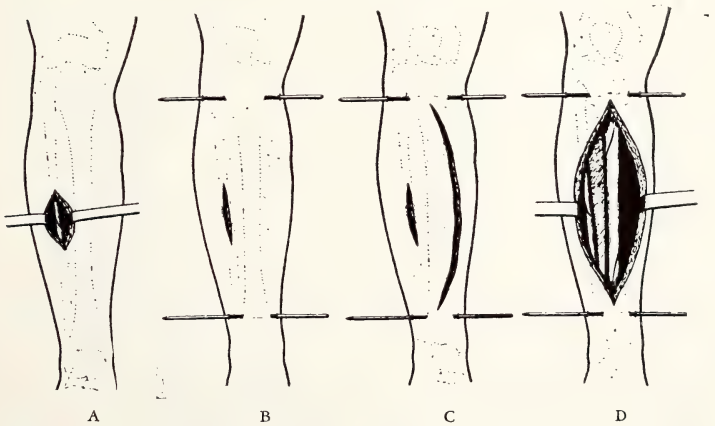

FIG. 4. A, open osteotomy of fibula, middle third. B, insertion of Steinmann nails into tibia. C, long semilunar skin incision over anteromedial surface of tibia. D, spiral incision of periosteum of tibia.

if the shortening operation must be undertaken. (Fig. 1.) I have used this procedure to shorten limbs when overgrowth is on the affected side. Solid union is obtained in eight weeks.

If surgeons would study the problem seriously and become familiar with the tissues that must be handled in preparation to lengthening

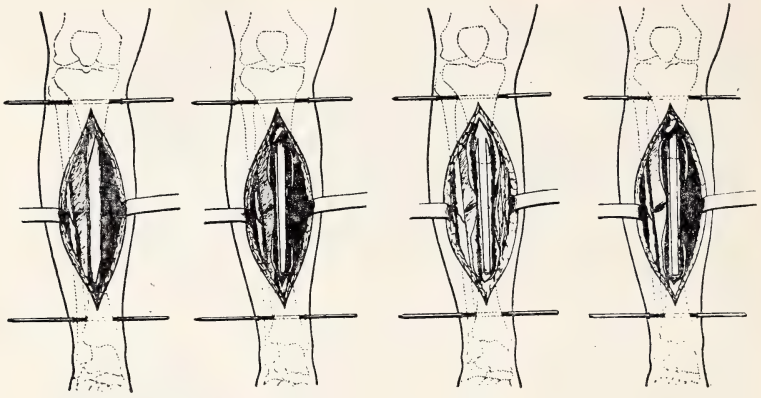

FIG. 5. A, incision of interosseous membrane. B, two long circular saw incisions at right angles to the anteromedial surface of the tibia. C, two saw cuts from upper ends diverging to periphery of tibia for a distance equal to increase to be obtained. D, completion of plastic osteotomy—cross cut anteromedial surface of tibia between lower ends of long incisions.

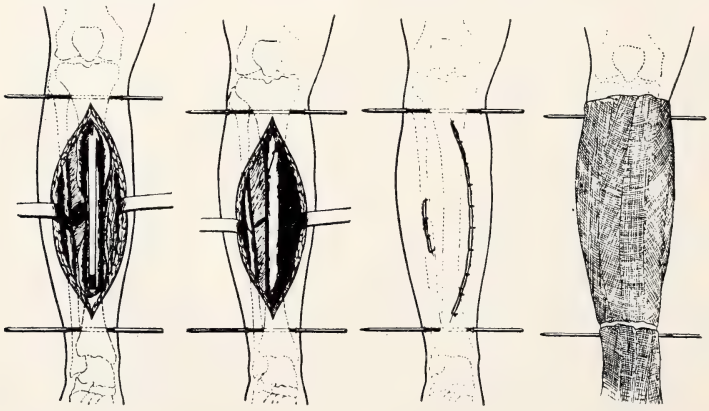

FIG. 6. A, tested for break in continuity. B, several interrupted sutures in periosteum. C, skin wounds closed with plain o catgut. D, vaseline gauze dressing including upper pin and up to lower pin. Separate vaseline dressing to foot including the lower pin.

their results would be better. Lengthening should be performed in selected cases, and the patients should try elevated shoes in order to correct secondary conditions such as scoliosis before the operation on the extremity is undertaken.

The physiology and function of the tissues to be lengthened must be kept in mind. Trauma of the structures at operation might produce a poor end result because of ensuing complications. The arteries must be remembered, since as they are stretched the lumen decreases in caliber. If this is done too rapidly thrombosis may result in the distal portions because of the diminished rate of flow. Experience has shown that if the limb is kept elevated above the patient's heart level to ease the venous and lymphatic return and that if the lengthening process is gradual, no circulatory complications will result. Increase of length of not more than 1/32 inch twice a day has been accepted by the writer as a safe procedure in actual practice. Under similar conditions peripheral nerve function has not been interfered with. This is true in non-poliomyelitic cases.

After the leg lengthening operation has been decided upon, the operative technique and apparatus should be considered. Any ap-

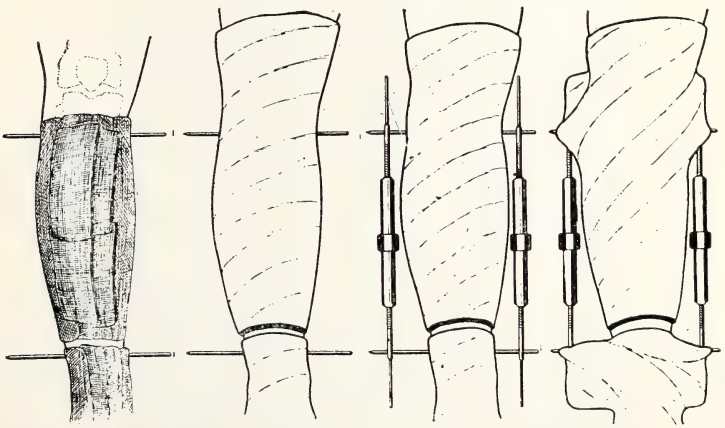

FIG. 7. A, thin sterile dressings. B, circular plaster including knee, upper pin, and operative area up to lower pin. Separate plaster for foot including the lower pin. C, application of apparatus medially and laterally to pins. D, incorporation of apparatus to the casts with plaster.

paratus familiar to the surgeon that will retain the fragments in a functional alignment during the process of gradual lengthening and thereafter until union has taken place is satisfactory. One should, however, also consider the nursing problem and the safety of a patient while at the same time preventing any damage or interference to the operation. Many of the apparatus used are too cumbersome. Patients cannot move while the apparatus is in use.

The writer has designed a simple leg lengthening apparatus combined with plaster of Paris technique that answers the purpose admirably. The fragments are held in practically anatomic position if a simple rule in applying it is remembered. It remains as part of the circular plaster until union is demonstrated by *x*-ray. And because of lightness and its control of the operative site the patient can be moved about with ease. If necessary, he can be permitted to slide down a chute in case of a fire alarm, with safety to life and limb.

The apparatus consists of two Steinmann nails, one for each

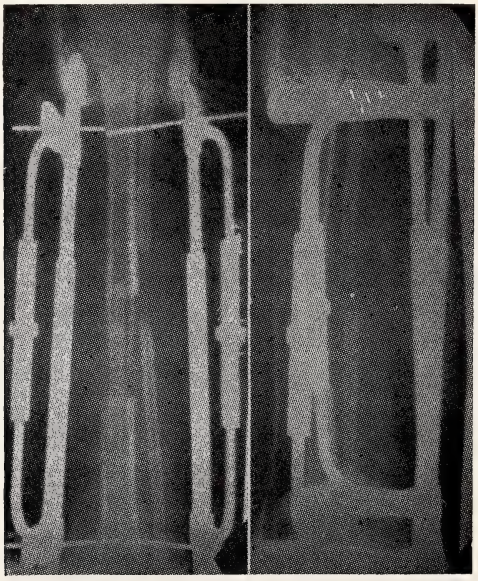

FIG. 8. X-ray at end of lengthening. Shows fragments in good alignment although lower pin broke.

fragment. Two isometric parts of the apparatus proper consist of telescope tubes, the inner one calibrated. These have posts attached between which is a turn-buckle arrangement for lengthening after the set is applied to the Steinmann nails and fixed with plaster. There is a simple gauge — a flat piece of metal with a hole at each end so distanced as to give the distance between the end posts when the instrument is closed or at zero.

The writer has found this procedure successful in obtaining an average increase of length of 2¾ inches in tibiae. The steps of the operation follow. The operation is performed with a tourniquet applied well above the knee. The order of the steps is important.

1. Open osteotomy of fibula at junction of the lower and middle third.
2. Subcutaneous tenotomy of tendon Achilles in contracted cases.
3. Insertion of the Steinmann nails parallel to each other and in a plane parallel to the crest of the tibia. This is very important for obtaining a resultant functional alignment. When properly

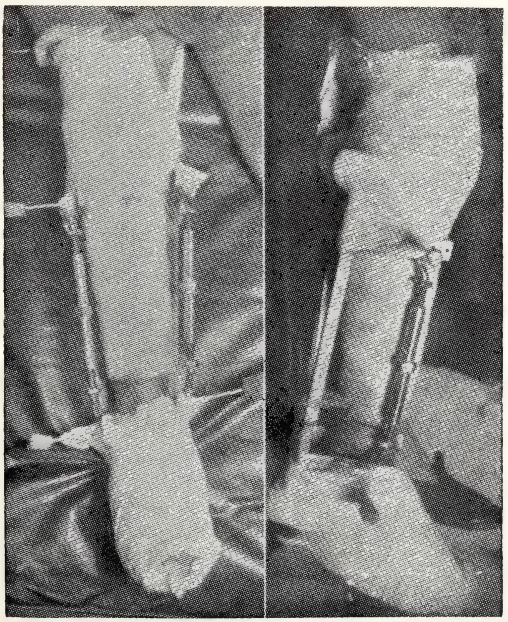

FIG. 9. Photograph taken just before patient returned home. Turnbuckles had not yet been covered with plaster.

carried out in practice the alignment has been practically anatomic. The nails are distanced apart with the aid of the simple guide.

4. Semi-eliptical skin incision on anteromedial surface of the tibia is made between the nails.

5. The periosteum is cut in modified spiral to permit proper retraction while doing the plastic osteotomy and later to produce a periosteal tube.

6. With great care the interosseous membrane is then severed. The line should be between the break in continuity of the periosteum on tibia and the osteotomy in the fibula.

7. Having by now the break in continuity of the fibula, interosseous membrane and periosteum of the tibia, the next procedure is the plastic osteotomy of the tibia. This consists of the following steps. Two long saw cuts, slightly closer together distally, about ½ inch apart, and twice as long as the increase in length desired, are made into the anteromedial surface of the tibia, i.e., if the increase is to be 3 inches, the long saw cuts must be 6 inches long.

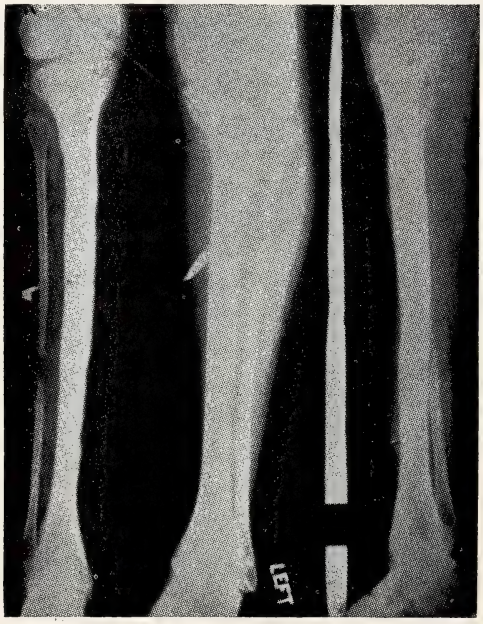

FIG. 10. End result compared to patient's normal leg.

With the same Albee saw two cuts are made from the upper ends of the long cuts diverging towards the periphery of the tibia for a distance equal to the increase to be obtained. These latter incisions are connected subperiostelly (posterolateral aspect of tibia) with a Gigli saw. The plastic osteotomy is then completed when the two long incisions are connected by a saw cut at their distal ends.

8. At this point a test for complete break of continuity of the necessary tissues is checked upon by pulling the Steinmann nails apart. If the procedure has been carried out carefully the fragments of the tibia can be pulled apart about ¼ inch without very much tension.

9. The wound is now closed. The periosteum is sutured with several interrupted No. o chromic catgut sutures. The skin is closed with No. o plain.

10. Vaseline gauze dressing is applied in two parts. One includes the upper pin region, the knee and leg up to the lower pin. Care must be taken not to include the lower pin in the first part. The second part includes the lower pin region and foot. The gauze dressing is applied similarly in two sections.

11. The circular plaster dressing is also applied in two parts just as the vaseline gauze and gauze dressings. The break in continuity is just above the lower pin.

12. At this point the isometric parts of the apparatus are applied to the pins medially and laterally and fastened with plaster bandages to the circular plasters already applied.

The patient is returned to his bed with instructions to have the extremity elevated. The turnbuckles for lengthening are turned about twelve hours postoperatively. The turns are made twice a day to obtain 1/32 inch increase or 1/16 inch in twenty-four hours. With this amount of increase the writer has had no morbidity or mortality. The average total lengthening has been 2¾ inches in patients ranging in ages from 11 to 36 years. Shortening had been due to poliomyelitis, arrested growth secondary to osteomyelitis of femur and tuberculosis of the knee.

When the required increase in length has been obtained several

turns of plaster bandage are applied over the turnbuckles to prevent meddling. The patient is observed several days and then discharged to go to his own or a convalescent home, with instructions to keep the limb elevated until the time for readmission to the hospital in two months for removal of the apparatus.

Under gas oxygen anesthesia the plaster is cut anteriorly and posteriorly. One half is removed carefully. The protruding pins are scraped free of all plaster, carbolized with 95 per cent and washed with alcohol to remove the phenol. The remainder of the plaster with the pins is then removed.

A snugly fitting circular plaster is applied, including the knee joint and moulded about the tibial condyles. If *x*-rays confirm union the patient is permitted to bear weight. Plaster is discontinued only when *x*-rays show good bone structure at the site of lengthening.

Summary

Leg lengthening operation is more physiologic than leg shortening in same type of case.

The new plastic osteotomy described has shortened the convalescence period by several months. Increase in length of not more than 1/32 inch twice a day with the leg lengthening apparatus described has not resulted in any morbidity or mortality. The average total increase has been 2¾ inches in patients varying in age from 11 to 36 years.

ARTHROPLASTY OF THE HIP
A NEW METHOD

By M. N. SMITH-PETERSEN, M.D.
Chief of Orthopaedic Department, Massachusetts General Hospital; Clinical Professor of Orthopaedic Surgery, Harvard Medical School

Up to the present time the procedure of arthroplasty has consisted in the shaping of two joint surfaces, mechanically suitable for function, and covering them with a lining that would tend to prevent re-ankylosis, as well as to allow the surfaces to glide against each other. In other words, the aim of the procedure has been to create all the elements that make up a joint, — joint surfaces, surface covering, and joint capsule. The blood clot that surrounds these structures at the conclusion of the operation organizes, forming a fibrous-tissue scar which tends to limit the function of the new joint; this is particularly true if it binds together the layers of the interposed lining. If it were confined to the capsular region, however, it would be less effective in inhibiting joint motion. This gave rise to the principle of the "two-stage, mold arthroplasty": By the introduction of an inert mold around which nature can do its repair work, two congruous surfaces, mechanically suitable for joint function, are created, and fibrous-tissue formation is confined to the periarticular region forming a joint capsule.

Glass molds (Fig. 1) were used at first, since glass is inert and causes a minimum amount of scar tissue to form. The use of glass had to be abandoned because some of the molds broke. Viscaloid, a form of celluloid, was then tried, but it caused too much foreign-body reaction. Even though the ideal material had not been found, the principle of the mold arthroplasty had been proved sound by the clinical and research work, and a preliminary report was published in 1925.[1] Eight years went by and still the right substance had not been found. In 1933 we went back to the use of glass (pyrex); the molds were considerably heavier and were tested under the

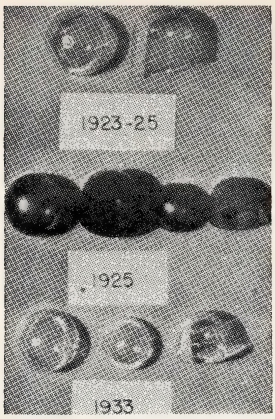

FIG. 1

Evolution of the mold:
1923: Glass.
1925: Viscaloid.
1933: Glass (pyrex).

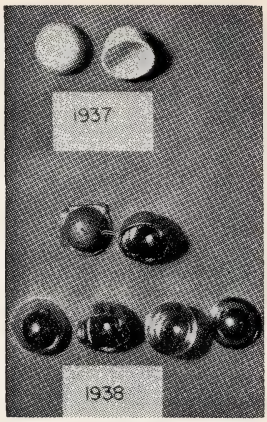

FIG. 2

Evolution of the mold:
1937: Bakelite.
1938: Unsuccessful and successful vitallium molds.

polariscope for evidence of strain under compression. In spite of this, some of these molds broke, but the majority stood up even under full weight-bearing. They were left in for periods varying from fifteen to twenty-five months.

In 1937 bakelite molds (Fig. 2) were made and used in one case; in this case the mold is still in place and the patient is doing well. At this time the author's attention was directed by his dentist, Dr. John W. Cooke, to Dr. Venable's work with vitallium.[3] Several unsuccessful molds were made; some were too thin and others were

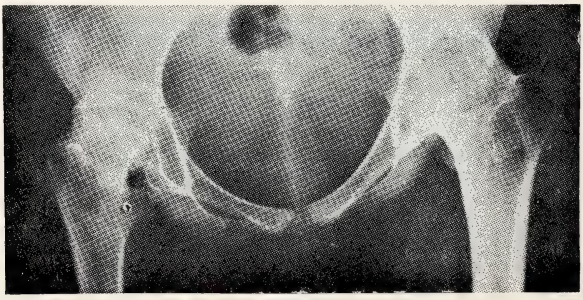

FIG. 3

Preoperative roentgenogram of case of bilateral ankylosis of the hip. Left, bony ankylosis; right, fibrous ankylosis.

too heavy. Finally, in the spring of 1938, the first successful vitallium mold was obtained, and Dr. Venable was consulted in regard to the advisability of using vitallium for this purpose. It was his opinion that it was entirely suitable, and, in June 1938, the first vitallium mold was inserted.

A case illustrating the use of a glass mold is that of a girl of nineteen, with ankylosis of both hips, which occurred as a complication of scarlet fever at the age of three years. On the left, there

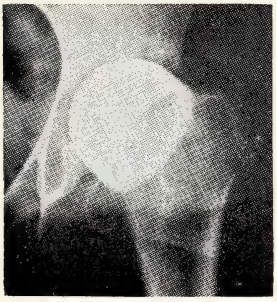

FIG. 4

Same case as shown in Fig. 3, one year after glass-mold arthroplasty of the left hip.

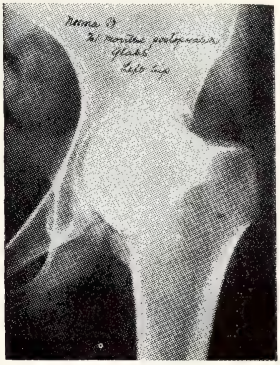

FIG. 5

Same case as in Figs. 3 and 4, twenty-one months after glass-mold arthroplasty. No absorption of head and neck: only 40 degrees of motion in flexion.

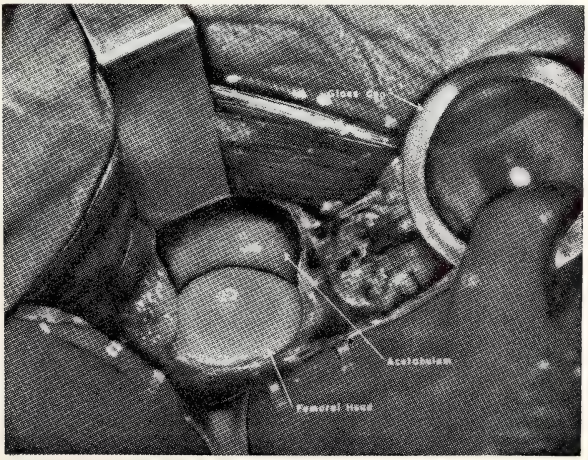

FIG. 6

FIG. 7
Section from femoral head.

FIG. 8
Section from acetabulum.

FIG. 9
Section from capsule.

FIG. 10
Section from femoral head.

was complete bony ankylosis, both by physical examination and by roentgenographic examination. On the right, there was no measurable mobility by physical examination, just an elastic give; the roentgenograms showed fibrous ankylosis (Fig. 3). A glass mold was inserted in the left hip and left in place for twenty-one months. At the end of this period there was only 40 degrees of motion in flexion from 30 degrees of permanent flexion; there was a fair amount of motion in rotation, as well as in adduction and abduction. The range of motion then was markedly limited, although not accompanied by pain. A roentgenogram (Fig. 5) taken at this time showed most satisfactory repair to have taken place, both inside and outside the glass mold. On removal of the mold, congruous joint surfaces were found; both the head of the femur and the acetabulum were covered by a firm, smooth, glistening lining, well adapted to joint function (Fig. 6). A fibrous capsule of no more than normal thickness had formed; it had a lining which grossly could not be differentiated from synovial lining. Even though we had all the elements present necessary for joint function, it was deemed unwise to expose this joint to the destructive effect of exercises required to restore satisfactory function. It must be kept in mind that this patient had an ankylosed hip on the other side as well, and that consequently the operated hip would be exposed to excessive wear and tear. Under the circumstances we were justified

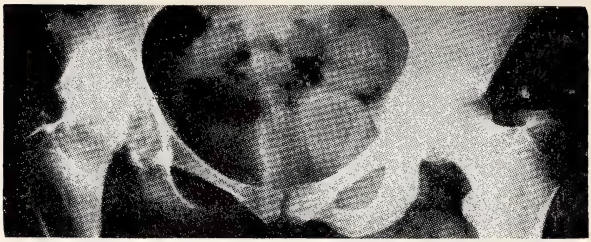

FIG. 11

Preoperative roentgenogram, showing recurrence of ankylosis following fascialata arthroplasty for the relief of bony ankylosis.

FIG. 12

Same case as in Fig. 11, one month after insertion of glass mold.

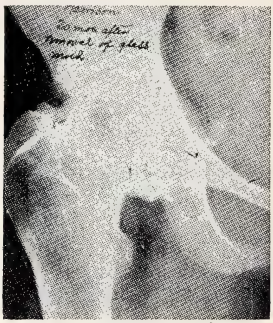

FIG. 13

Same case as in Figs. 11 and 12, twenty months after removal of glass mold and three years after insertion of glass mold. No absorption of head and neck; 80 degrees of motion.

in removing specimens from the head of the femur, capsule, and acetabulum, and inserting a vitallium mold.

Histological examination of these specimens showed the newly formed joint surfaces to consist chiefly of fibrocartilage, which in some areas approximated hyaline cartilage in character; the newly formed capsule consisted of dense fibrous tissue with a true synovial linings (Figs. 7, 8, and 9). In another case in which the mold remained in place for twenty-five months, a specimen from the femoral head showed highly developed hyaline cartilage (Fig. 10). These sections are the best that we have obtained in our histological studies of the type of repair which takes place in response to an inert mold interposed between two cancellous-bone surfaces. Normal mechanical conditions of friction and pressure must obtain for this

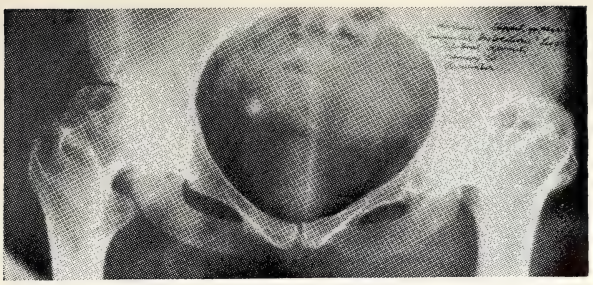

FIG. 14

Preoperative roentgenogram of case of bilateral deformity of the hip.

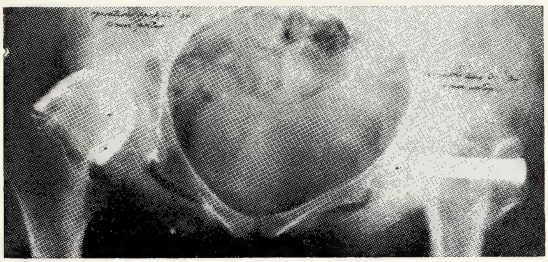

FIG. 15

Same case as shown in Fig. 14, after bilateral arthroplasty with transplantation of the trochanter on the left; glass-cup arthroplasty on the right. Ten months after insertion of glass mold; no absorption of head and neck.

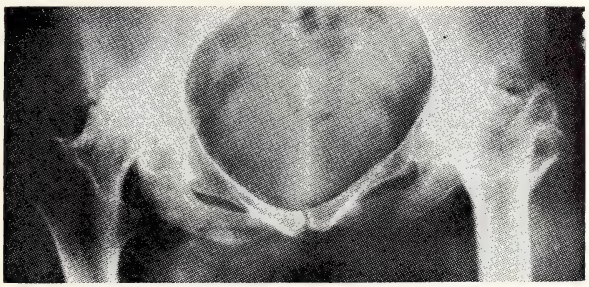

FIG. 16

Same case as shown in Figs. 14 and 15, three years after removal of glass mold and four and one-half years after insertion of glass mold. No absorption of head and neck; 70 degrees of motion in flexion.

type of repair to take place; this is our unproved conviction. For this reason, the mold is held in place by position only, so that the femoral head can move inside the mold and the mold can move inside the acetabulum.

Gradual absorption of the head and the neck of the femur some-

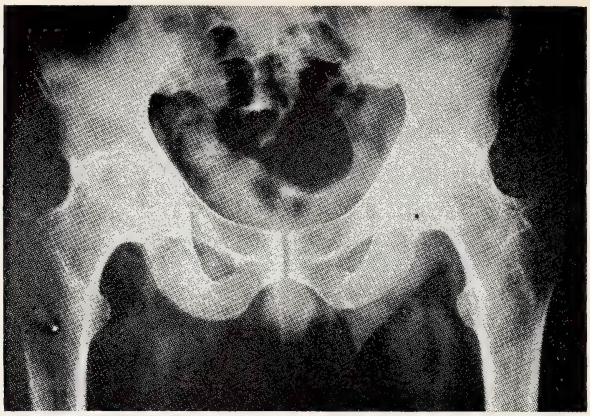

FIG. 17
Preoperative roentgenogram of case of bilateral bony ankylosis of the hip.

FIG. 18
Same case as shown in Fig. 17. Bilateral arthroplasty with vitallium molds.

times occurs in fascia-lata arthroplasties. This has not been observed in the cases operated upon by the glass-mold method. Unfortunately in only three cases has the mold been in place for a period long enough to justify us in drawing conclusions. Figures 4 and 5 show the roentgenographic appearance in one case one year after operation and twenty-one months after operation; there is no apparent evidence of absorption. The other two cases are shown in Figures 11, 12, 13, 14, 15, and 16. These three cases are not sufficient to prove this point, but with the use of vitallium molds, which in all

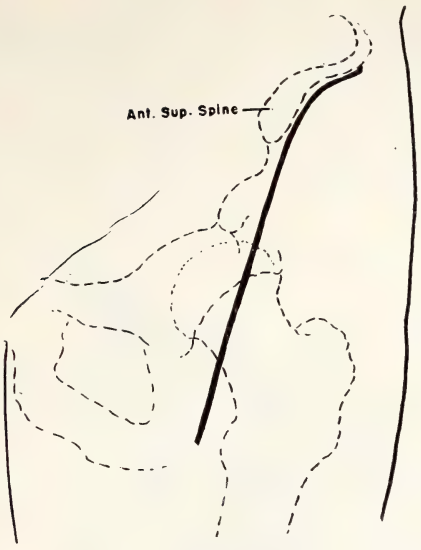

FIG. 19

probability may be left in place indefinitely, additional knowledge on this point will be gained.

Fifteen years have elapsed since this work was started. That the principle of the two-stage mold arthroplasty is sound was proved by the use of the glass molds. Since these are radiotransparent, it has been possible to follow the different stages of bone repair. The fear that the molds might break has restrained us as far as effective exercising is concerned. With the advent of vitallium this restraint has been removed, and the postoperative course of events has been accelerated. The question now arises whether the original mold principle may not have to be sacrificed; if vitallium proves to be inert, even when interposed between two moving surfaces, there may be no reason for the second stage, — that is, the removal of the mold. We must keep in mind the possibility of absorption of the head and neck, as has already been pointed out. A typical case of bilateral bony ankylosis of the hip, treated by arthroplasty with the vitallium molds, is shown in Figures 17 and 18.

Operative Technique

A satisfactory exposure of the hip joint has always been difficult to obtain until the approach for "acetabuloplasty"[2] was developed. The steps for the approach for arthroplasty are essentially the same as those for acetabuloplasty.

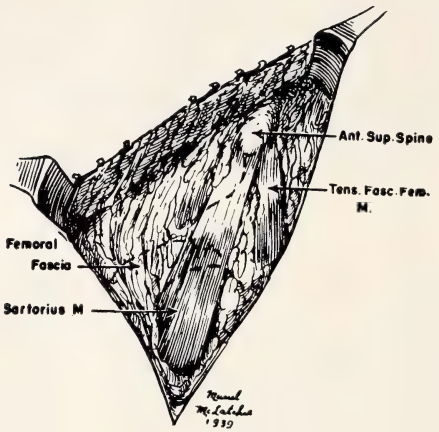

FIG. 20

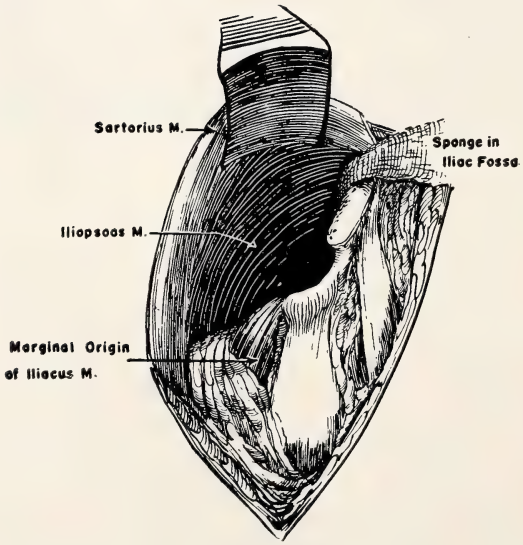

FIG. 21

The incision extends along the anterior third of the iliac crest to the anterior superior spine, and then curves slightly medially along the lateral border of the sartorius muscle (Fig. 19). Immediately inferior to the anterior superior spine one finds the plane of division between the sartorius and the tensor fasciae femoris. The femoral fascia is incised along the lateral border of the sartorius, exposing the direct head of the rectus femoris. By sharp and blunt dissection

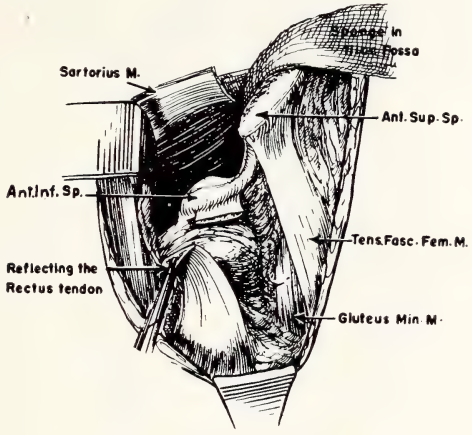

FIG. 22

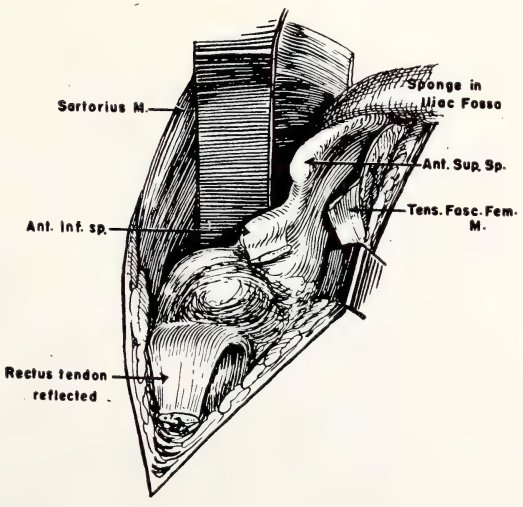

FIG. 23

the attachment of the direct head of the rectus femoris to the anterior inferior spine is defined (Fig. 20).

Between the origin of the abdominal oblique and the sartorius muscles mesially and the gluteus medius and the tensor fasciae

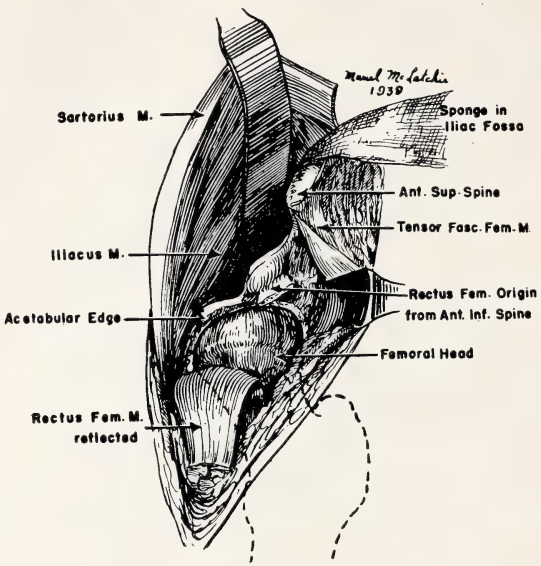

FIG. 24

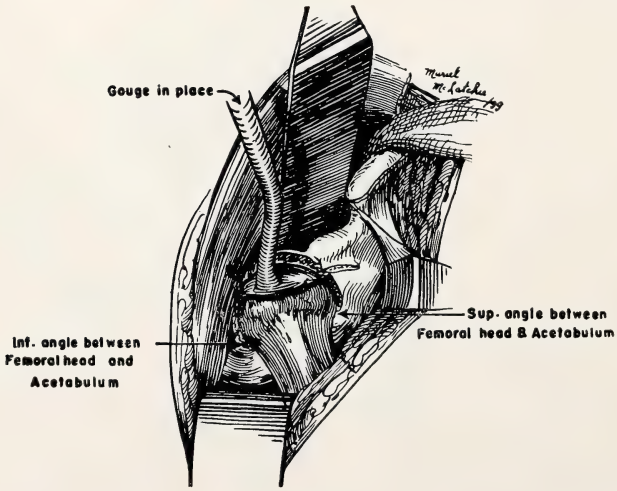
Gouge in place
Manuel McLatchie 1939
Sup. angle between Femoral head & Acetabulum
Inf. angle between Femoral head and Acetabulum

FIG. 25

femoris muscles laterally is a definite sulcus, which should be defined before the periosteum is incised and reflected from the anterior iliac crest and the anterior superior spine. (See Figure 21.) By incising the periosteum between the anterior superior spine and the anterior inferior spine one can reflect the iliacus subperiosteally from the iliac fossa. A blunt instrument is then inserted mesial to the anterior inferior spine in order to get a lead to the plane of

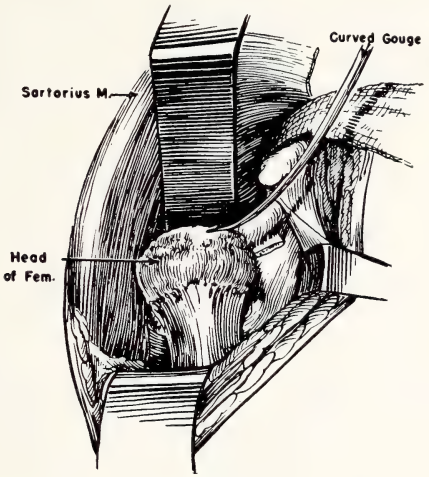

FIG. 26

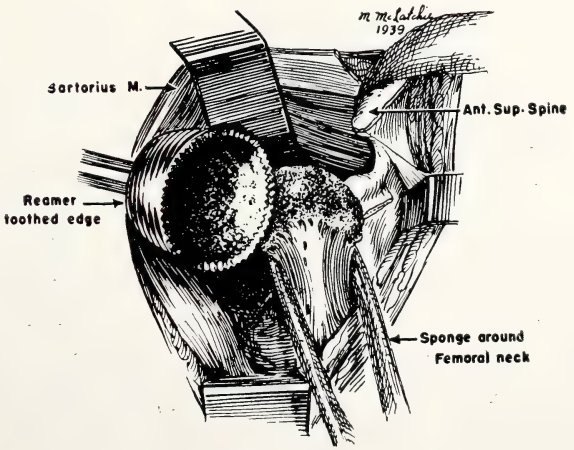

FIG. 27

division between the main portion of the iliacus muscle and its marginal origin. The author has found this procedure very helpful. The tendon of the rectus femoris (Fig. 22) is divided just below its origin from the anterior inferior spine and reflected from the anterior capsule; it is temporarily sutured to the inferior angle of the incision in order to keep it retracted without traumatization (Fig. 23). At times it becomes necessary to reflect the origin of the tensor fasciae femoris and gluteus medius from the lateral aspect of the ilium in order to facilitate the dislocation of the head of the femur (Fig. 24).

The anterior capsule is excised along with the marginal origin of the iliacus, as well as a portion of the Y ligament (Fig. 25); this exposes the anterior aspect of the joint. In cases of bony ankylosis particular care should be taken to develop the angle between the femoral head and the acetabular margin, both superiorly and inferiorly (Fig. 26). Between these two points it is usually possible to define a sulcus representing the line of fusion between the acetabulum and the femoral head. The osteotomy can then be carried out along this line with the assurance that the new joint surfaces will coincide in location with the original joint surfaces. Special gouges are used for this purpose; they are shaped to correspond to the curves of a normal femoral head.

If dislocation is found to be resisted by the muscle arising from the lateral aspect of the ilium — that is, the tensor fasciae femoris, the gluteus minimums, and the gluteus medius — these may be reflected subperiosteally as already pointed out (Fig. 24).

Any marked bony projection is removed by means of thin, curved gouges (Fig. 26) before the reamer is applied for the final finishing off (Fig. 27). This reamer has a toothed edge, so that it cuts its way around the circumference of the head and neck.

Attention is next directed to the acetabulum; its anterior wall can be sacrificed to a considerable extent. By the use of the hip gouges the floor and posterior wall can be made congruous with the surface of the femoral head. Occasionally a male reamer is used for finishing off the surface of the new acetabulum. If the circulation

of the femoral head is deemed insufficient, drill holes are made in the direction of the femoral neck. The vitallium mold is then applied (Fig. 28). It should not be fixed to the femoral neck by screws or nails, since by so doing abnormal mechanical conditions are created.

Since the approach follows structural planes, the closure is very simple. The rectus femoris is sutured to its proximal stump (Fig. 29); this brings its posterior tendinous surface in apposition to the femoral neck and to the edge of the mold. Suturing the periosteum

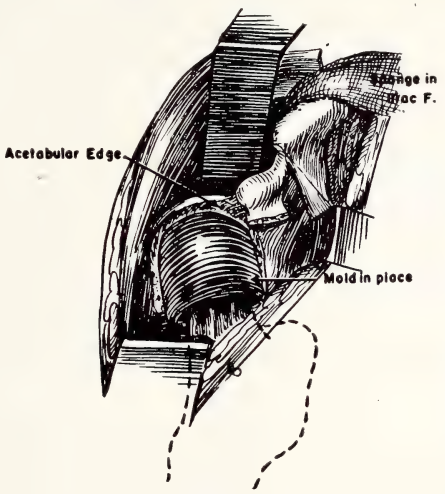

FIG. 28

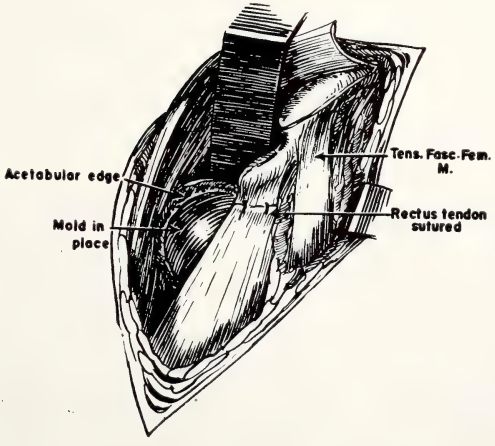

FIG. 29

of the iliac crest to the origin of the muscles arising from the lateral aspect of the ilium allows the sartorius and the iliacus to drop back over the mesial portion of the joint (Fig. 30).

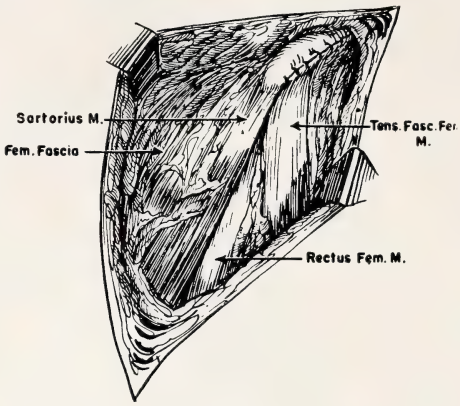

FIG. 30

Points in Operative Technique Deserving of Emphasis

The author wishes to emphasize the following points in the operative technique which his experience has shown to be of importance:

1. The approach must be developed with the utmost respect for anatomical structures. The intrapelvic exposure of the acetabulum is absolutely necessary; it is the exceptional case, however, that requires the reflection of the sartorius from the anterior superior iliac spine.

2. Reflecting the origin of the gluteii from the lateral aspect of the ilium facilitates the dislocation of the hip.

3. After excision of the anterior capsule and before dislocating the hip, hypertrophic overgrowth of the head should be removed. This is helpful for two reasons: It facilitates dislocation and it also assures proper alignment of the newly shaped head to the neck. In cases of bony ankylosis it is important to develop the inferior angle, or junction between the neck and the inferior acetabulum, as well as the superior angle, or point of junction between the superior neck and the superior acetabulum. The curved osteotomy between these two points is then bound to be very close to, or actually to coincide with, the old joint line.

4. Sacrificing the anterior capsule and the Y ligament of Bigelow does not weaken the anterior aspect of the joint sufficiently so that dislocations or subluxations occur. So far the author has had no such complications, and in the cases in which he has removed the mold he has always found the necessary dislocation difficult to perform. If the anterior capsule is left intact, it gives rise to excessive scar formation, which limits joint function.

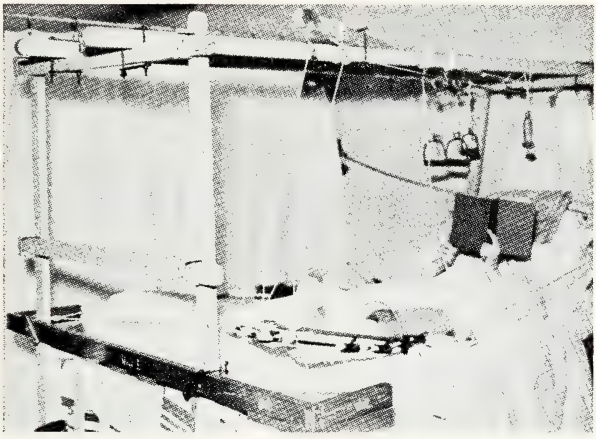

FIG. 31

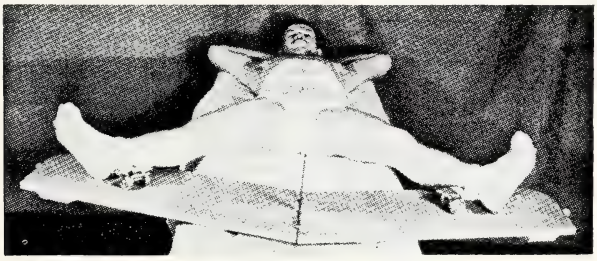

FIG. 32

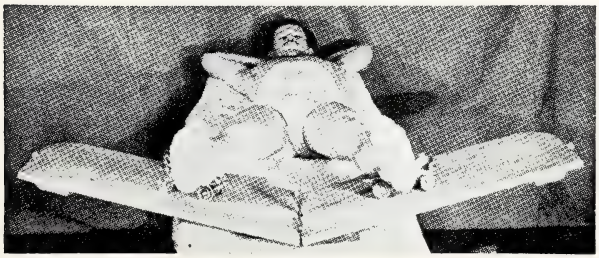

FIG. 33

Postoperative Treatment

The striking feature in the postoperative course is the relative absence of pain after a decidedly major surgical procedure; even during the first few days the patient is able to move around in bed without discomfort. The operated extremity is suspended in a Hodgen splint with a Pearson attachment (Fig. 31). The suspension is so arranged that the patient can give himself assistance in performing active exercises in all directions, as far as both the hip and knee are concerned.

At the end of the second week roller-skating exercises are started (Figs. 32 and 33). The roller skates are strapped on the back of

FIG. 34

FIG. 35

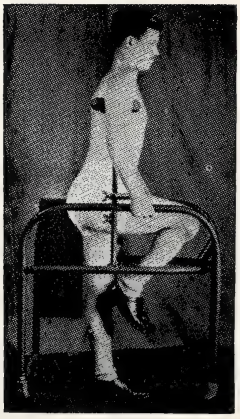

FIG. 36

the legs, just above the ankles, and a hinged platform is placed on the bed, furnishing a smooth surface for the roller skates. This arrangement allows the patient to exercise the abductors and adductors with a minimum amount of effort. As muscle strength increases, the wings of this platform are raised, thereby increasing the resistance to abduction; this inclined plane also has the desirable effect of adding motion in flexion. By raising the middle of the platform, so that the wings slope downward, abduction in extension is obtained. These exercises are carried out twice a day. Except for these exercise periods, the extremity is kept in the traction-suspension arrangement for at least four weeks.

In approximately four weeks the patient is allowed to sit up in a chair. As a rule, he is able to exercise on a stationary bicycle (Fig. 34) sometime during the first week out of bed. At first the range of joint motion is insufficient to allow him to push the pedals through a complete revolution, but see-sawing back and forth is very beneficial, and within a week's time he is usually able to make a complete revolution. This accomplishment is almost always accompanied by marked encouragement on the part of the patient and, consequently, improvement in gait. By gradually raising the seat of the bicycle, motion in extension of both hip and knee is increased; similarly, by lowering the seat, additional motion in flexion is obtained (Fig. 35).

Training the patient to use crutches after a long period of recumbency is always difficult. This is greatly facilitated by the use of a walker (Fig. 36). Goose-stepping should be emphasized, as the patient always has a tendency to favor the hip by bending the knee.

During the hospital stay the patient is also instructed in specific exercises for flexion, extension, abduction, and internal rotation. After discharge these exercises are kept up indefinitely; whenever possible exercising on a stationary bicycle is continued for a period of months. Crutches are used on the street for a minimum of six months; in the house, the patient frequently gets along with a cane in as short a period as two months after operation.

Summary

The method of arthroplasty described is based on a new principle, — that of interposition of a mold by which nature can do its repair work; this mold is removed at a secondary operation, leaving congruous joint surfaces, which are capable of function because their covering approximates normal cartilage. Even though this two-stage mold arthroplasty has been proved practical, present indications are that the "mold principle" should be abandoned; if this be true, the mold becomes a permanent insurmountable barrier to recurring ankylosis.

No end results can be reported, since the twenty-nine patients in whom the vitallium mold has been used have all ben operated upon since June 1938. The very fact that we have felt justified in doing as large a series as this in a relatively short period of time points to the success of the method during the first few months. Furthermore, the experience gained from the use of the glass molds has given us confidence in the soundness of the method.

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TRANSPLANTATION OF A TOE TO REPLACE A THUMB, FOLLOWING NIKOLADONI'S METHOD*

By A. R. KOSMATII

The loss of a thumb constitutes invalidism, in addition to presenting an ugly sight. This loss involves change of one's qualifications for, or even complete abandonment of, one's trade or profession. Moreover, persons so crippled cannot be drafted into the Army, if the loss is on the right hand. One tractor-mechanic declared: "Do whatever you wish, provided I have the thumb and get an opportunity to join the Army." Surgeons' interest in devising a definite surgical technique to restore the employability of persons so crippled has been expressed in the work of Nikoladoni (1891) and other physicians.

A few cases have already been recorded, in which the hand or the thumb was surgically reconstructed. These cases suggested a number of authors to systematize the previously used methods. Richter's technique of reconstruction of the thumb consists in two processes: (1) the restoration of the thumb out of the remaining structure of the limb, and (2) transplantation of skin as well as of a healthy finger or toe.

Kazakievitch, in describing two cases of the restoration of the thumb, gives a detailed classification of techniques used for such restoration:

"I. Reconstruction method: (a) transplantation of skin with the subsequent transplantation of bone; (b) simultaneous transplantation of both; (c) simultaneous transplantation of both after a preliminary bone transplantation.

"II. Methods utilizing the remainder of tissues on the affected hand: (a) phalangization of the bone of the hand; (b) the utilization of the adjoining finger.

* Translated by R. B. Winn.

"III. Method of transplantation: the utilization of (a) a toe or (b) a finger."

In evaluating these methods, Kazakievitch contends that reconstruction methods are too complicated to yield good functional results. Phalangization is advisable only when all fingers of the hand are lost; but it does not eliminate deformation of the hand, when the thumb alone is lost. Joyce's technique makes sacrifice of a healthy hand, which leads to a new deformity. Schmidt's technique sacrifices the adjoining finger.

Consequently, the most advantageous technique is that of Nikoladoni, suggested by him in 1897 and applied first in the case of a five-year-old boy. The operation, in this instance, was not fully satisfactory, insofar as the finger-nail phalanx degenerated. But the next case, that of a twenty-five-year-old man, was completed with a perfect functional success.

The statistics of successful operations following this technique is as follows:

Nikoladoni himself operated on 9 cases. The same technique, with slight modifications, was used in other countries on 26 cases. Among Russian surgeons, V. M. Svetukhin employed the method in 1926 (man, twenty-year-old), Vreden in 1930, Borissoff in 1933, and Kusslik in 1934.

To these we may add our own case.

On June 29, 1940, G. P. K., 28 years old, visited me and complained of the loss of his thumb on the left hand. The deformity was so depressing the patient that he was compelled to hide his injured hand. Moreover, the absence of the thumb interfered with his ability to work. The patient happened to be quite intelligent and fairly educated; in fact, he was familiar even with the work on transplantation of fingers. He came to ask me to perform the operation. The warning that the operation may be a failure did not discourage him at all.

His case history revealed that about two years before he fell off a horse and badly hurt his thumb. It was amputated shortly after-

wards in the local hospital. There was pus in the wound for several weeks and delay in cicatrization.

After all preparations were completed, it was decided to use the second toe of the left foot. On July 9, the operation was performed under local anaesthesia (novocaine).

1ST STAGE. — Using a circular incision, the scars on the hand were removed. The tendons of the thumb were loosened.

2ND STAGE. — An incision was made on the left foot, from the region of the metatarsal bone to the base of the second phalanx. Another incision was made perpendicularly to the first one, to reach the side surfaces of the toes. Both incisions formed the figure of the letter "T". The incisions were made as deep as the tendons. The extensor tendon was severed between the 1st and 2nd phalanx. The first phalanx of the second toe was then removed and the head of the corresponding metatarsal bone sawed off. The tendon above so formed space was removed. The toe remained connected with the foot by means of a bridge of soft tissues on the side of the sole.

The patient was seated, his lower limb sharply bent, at pelvis and knee. The left hand was placed on the inside of the lower limb, while fingers were placed on the forefront part of the foot.

3RD STAGE. — The extensor tendons were sutured above the bone of the hand, a few millimeters from the point of contact between the bones. Sutures were placed in the skin.

4TH STAGE. — A small tampon of gauze was placed under the bridge of the foot. The operated toe was thereby slightly lifted, thus giving a better access to the wound. The upper and lower limbs were fixed in this position by means of a plaster band connecting the hip, the middle third of the fore-shoulder and the sole of the foot.

The sutures were removed on the ninth day. The toe had its normal appearance.

On July 30, the second operation was performed, under local anaesthesia (1% novocaine). The bridge was cut, the extensor tendons were firm. A slight suppuration made it necessary to take out the sutures.

On August 9, a slight cyanotic condition developed at the base of the nail. It happened on the thirty-fifth day after the first operation. The nail came off a few days later. The finger developed new epithelization. Three months later a new nail was formed. The patient was dismissed and went to work on September 1.

The patient was under observation all along; and it may be stated that temperature sensibility appeared on the fourth month and pain sensibility on the 5th. The patient was seen last time after eight months. A complete transformation of the finger could be noticed. All the forms of sensibility were restored, though tactile sensibility was subnormal. The new finger was quite active in grasping movements; it was of considerable help in work. The patient was fully satisfied with the result.

1. In analyzing the available literature on the topic and comparing our own case with those of other authors, the case can be classified as satisfactory.

2. There is no unanimity of opinion as to which hand or foot should be preferably used in such cases. Vreden, Svetukhin, Kusslik, and Kazakievitch chose to take the hand or foot of the same side; Borissoff, of the opposite side.

3. Of all the methods of restoration of fingers and thumbs the best method appears to be that of Nikoladoni, as modified by Svetukhin.

4. There is no agreement as to what toe should be used. In the cases known to us, the large toe was used in 10; the second toe, in 10; the little toe, in 1. Our preference is the second toe, because its absence affects least the activity of the foot; the little toe is clearly too small for the purpose.

5. Svetukhin's modification of the method — the removal of the basic phalanx and the head of the second metatarsal bone — simplifies the operation.

6. The patient should be prepared, before the operation, for the position to be assumed during the first period of the operation.

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REHABILITATION IN THE BRITISH EMERGENCY MEDICAL SERVICE

By Sir ROBERT STANTON WOODS, M.D., F.R.C.P.
Consultant Adviser in Physical Medicine, Member of the Committee on Rehabilitation, E.M.S., Ministry of Health

The Oxford Dictionary defines "rehabilitation" as "restoration to privileges." In the medical sense this would signify restoration to the privileges of health, so far as this is possible. In considering the rehabilitation of an individual it is logical to include not only the whole therapeutic procedure but also the mental and material environment to which he is subjected from the moment of the onset of his disease or the infliction of his injury. In the more restricted sense of the term, however, which alone is brought under survey here, efforts to rehabilitate can be considered under the heads of passive physical therapy or the application of physical agents, active (volitional) exercise, and productive occupation.

In many instances the whole of the programme may with advantage be started as soon as the patient arrives in a hospital bed. In general, it can be stated that, if there are no indications to the contrary, the earlier this special rehabilitation treatment is begun the better. Thus, for example, a patient who is admitted from the waiting-list for an abdominal operation will often benefit from pre-operational abdominal and general exercises; the precursors of an operation for an internal derangement of the knee may very usefully be faradic and "active" (volitional) contractions of the thigh muscles; while an individual with a lower limb in plaster ought to begin weight-bearing exercises as soon as he is ambulatory.

In the past a prescription of "rehabilitation" therapy has too often been made out with a view solely to recovery of the diseased or injured region, to the neglect of the general mental and physical make-up. Recent conceptions of the aims of treatment render it improbable that this error will persist; indeed, the danger is that

the pendulum should swing too far, to the neglect of those other, equally indispensable, extrinsic factors — massage, electrotherapy, thermotherapy, etc.

Aims

In the strict sense of the term there is no form of treatment which can be designated "curative"; in choosing any therapeutic or prophylactic procedure, one's aim ought always to be to elicit such responses in the tissues and in the mentality of the individual as are likely to assist in the recovery or maintenance of health. To no part of medical or surgical treatment does this apply with greater force than to so-called "rehabilitation" therapy; the physical agents employed can, without gross exaggeration, be looked upon as tissue "insults," and it is necessary to be continually alert lest the insult be so gross, or the tissue so debilitated, that the latter is incapable of response, and consequent harm result.

The therapeutic effects of almost all these physical agents depend primarily upon a stimulation of the peripheral circulation — venous and possibly lymphatic in some cases, arterial in others. As regards massage, this is obvious. To the effects, however, of electrically stimulated muscle contraction a similar statement applies, and this therapeutic measure is an excellent instance of the ease with which the optimum dose of the tissue stimulus may be overstepped. Until recently the therapeutic effectiveness of this stimulus has been in dispute. Magladery and Solandt (1940) have, however, demonstrated that the wasting of denervated muscle can be retarded by such stimulation, properly applied. They have further shown that the maximum effective "time" dose is of the order of "a stimulus which is interrupted for 5 seconds every 5 seconds and applied for two minutes three times a day." This is in contradistinction to the method usually taught, in accordance with which a current of almost maximal intensity of stimulus is applied at a rate of about 2 per second with no prolonged pause, the whole treatment lasting up to 10 minutes or even longer — a total of stimulation time incomparably greater than that of Magladery and Solandt's maximum.

This matter is worthy of stress, especially as, in a recent article (Gutmann and Guttmann, 1942), the statement appears that "the galvanic exercise treatment is the more successful the more the individual [denervated] muscles are exercised." Over-stimulation of such wasted and grossly abnormal muscle is entirely comparable to the administration of large doses of strychnine to a failing myocardium. A similar caution is relevant to all physical, as indeed to all therapeutic, agents. The dose must be graduated in accordance with the residual capacity of the individual and of his tissues to respond; an adequate dose for one would constitute gross overstimulation in another.

Certain conditions also are notoriously sensitive to excessive *active* use: that in which the danger is most commonly recognized is dislocation of an elbow, especially in children or adolescents, though certain derangements of the knee are also susceptible. On the other hand, the safe or rather optimum degree of activity can often be assessed only after trial, under skilled medical supervision. Every rehabilitation department ought therefore to be continually supervised by a medical man skilled in the use of physical agents. Reference will be made later to the lack of this feature in the majority of hospitals otherwise well equipped, and to the reasons for this defect.

There is a growing tendency to decry the value of so-called passive therapy and to depend almost entirely upon the therapy of active function. Both are indispensable and can often be usefully employed concurrently at certain stages in the history of an injury or an ailment. Where normal tissue function is for any reason suspended, and tissue nutrition, through defective blood supply, is in consequence suffering, artificial stimulation of functional and vascular activity may partially replace normal conditions. One of the most striking and tragic illustrations of neglect of this principle is the permanently board-like hand which may result from the complete immobilization, with weight extension and without physiotherapy, of an upper limb for a high humeral fracture. "Passive" and "active" therapy do not constitute stages in treatment. Volun-

tary effort ought to form part of rehabilitation treatment at as early a stage as it may do so with safety, and passive therapy is with advantage often continued long after recovery of function has begun.

In the British Emergency Medical Service there is very extensive provision of facilities for all these activities. Because in time of war the great preponderance of disability in the Services is due to injury, while in totalitarian war a large proportion of civilian disability is also due to enemy action, the earliest hospitals in the B.E.M.S. to be fully equipped in this respect were the so-called orthopaedic centres. At each of these there have for some time existed departments of physiotherapy, of local and general remedial gymnastics, and of occupational therapy. At every such centre which has been enlarged by the building of hutted extensions these activities are housed in several specially designed huts; while at those centres at which the original hospital buildings did not necessitate this enlargement, suitable indoor spaces have been allocated to these purposes and the appropriate structural alterations made.

It was, however, obvious from long before the beginning of the war that these comparatively few orthopaedic centres would be insufficient for the numbers of war casualties which occurred or arrived in this country. The next step, therefore, was a much wider provision of rehabilitation facilities in the Service, in accordance with a decision of the Minister that every Class I B.E.M.S. hospital of 300 beds and upwards should reserve and prepare enough space to accommodate physiotherapy and indoor treatment by remedial exercises.

Later still, three types of fracture department, "A," "B," and "C," were selected — "A" and "B" as parts of general hospitals for long-stay and short-stay fractures, respectively, while the "C" departments, for civilian out-patients, are situated partly in hospitals and partly in certain clinics. In connection with the "A" departments, as full provision for rehabilitation treatment, in proportion to size, is being provided as at orthopaedic centres; while "C" hospitals and clinics have been chosen because they already possess rehabilitation facilities adequate to their functions.

The *housing accommodation* for such a rehabilitation department at a large, hutted orthopaedic centre consists of the following: (1) A building, 144 ft. by 24 ft., for massage, electrotherapy, radiotherapy, thermotherapy (including short-wave therapy in some), and the earlier stages of remedial exercise; at one end of the building are "offices" for the staff. (2) A gymnasium, 60 ft. by 24 ft., for more advanced local and general rehabilitation gymnastics. (3) A room or rooms for handicrafts and carpentry.

Outdoor space is generally available for the more active forms of therapy, and full use is made of this, and especially of football, cricket, tennis, and even golf facilities. Stereotyped "P.T." is dead.

In *equipping* these departments with technical apparatus, at first only the most simple types were provided, and particularly such types as would be in greatest demand for the treatment of battle and bomb casualties. Gradually, however, it has been possible to supply some of the more specialized forms of equipment, and the rehabilitation departments are becoming more and more elaborately set out, while at the same time the provision of unessential varieties of apparatus is avoided.

The *technical personnel* which are recognized as being necessary to carry out the varied treatment belong to three groups — namely, members of the Chartered Society of Massage and Medical Gymnastics, male physical-training instructors, and occupational therapists.

With such facilities as have just been briefly outlined, rehabilitation activities at a large orthopaedic centre are obviously extensive, complicated, and diverse. The simplest of these begin in bed, and it is now the routine in B.E.M.S. hospitals for every patient who is confined to bed to perform at stated times during the day such exercises as are medically advisable, so that when confinement to bed is no longer necessary the individual ought to find himself at a much more advanced stage of general fitness than he would have been under the former regime of almost complete passivity. Preoperational exercise and muscle stimulation are also coming more and more into use, to the obvious advantage not only of the muscle

groups at the site of operation but of the patient's general tone and resistance.

All those who are ambulatory ought to attend the various departments. In the so-called "physiotherapy" department the members of the C.S.M.M.G. not only administer the various therapeutic agents there in use but also supervise the earlier stages of remedial exercise, with patients singly or in groups and exercising either freely or by means of gymnastic apparatus.

Many large hospitals are now provided with physical-training instructors, in the majority of instances supplied by the Army gymnastic staff and consisting of N.C.O.'s who, in addition to their instructional training, have undergone a special course of remedial gymnastics. As soon as a convalescent is capable of doing so, he joins one of the carefully graded groups for physical exercise. In its nature this is entirely divorced from the old "physical jerks," and is made up of a combination of more or less formal physical training with indoor and outdoor games. In the winter much of this treatment is carried out in the gymnasia, already described; but advantage is taken of any out-of-door space, and at many of the B.E.M.S. hospitals it is possible to make use of football, tennis, and golf rehabilitation.

Occupational therapy is a standard part of treatment at all orthopaedic centres and at every hospital with a "Group A" fracture department, and trained personnel for this work are increasing in numbers, the Ministry having instituted an intensive course of training at one of the orthopaedic centres. The remedial aspect of productive occupation is partly physical and partly psychological, and the occupations consist of light crafts such as weaving, basket-making, and wool-mat-making, as well as of heavier work, mainly carpentry. In addition to these, at many centres the hospital gardens function as remedial agents.

The fullest advantage cannot be taken of such a complex organization, in which the same patient is undergoing treatment in all the three main divisions of rehabilitation, unless there is an efficient system of timekeeping, and at some large B.E.M.S. hospitals such

a system is in use. This is under the supervision of an *organizer,* whose duty it is to see that every patient observes his therapeutic time-table.

MEDICAL PERSONNEL. — It must therefore be obvious, and it is now officially recognized, that *specialized medical supervision* of these activities is essential to the complete efficiency of a rehabilitation department in order to ensure the correct application of all the methods and physical agents used and, of even more urgent importance, to hold the proper balance between activity and rest in a population consisting not only of convalescents but of convalescents at varying stages of recovery. This medical supervision, however, has provided the most difficult of all the problems in connection with the organization, and it would be idle to suggest that the difficulty has been overcome. That it has not is due to the very great expansion of rehabilitation facilities under the Emergency Hospital Scheme — at the newly established orthopaedic centres, in all Class I hospitals of 300 beds and over, in the special fracture hospitals, and at certain other special centres, such as neuroses centres, head centres, etc.; whereas it is almost literally accurate to say that before the war there were no specialists in physical medicine attached to hospitals outside the Metropolitan Area and the comparatively few large provincial centres. Even in London a typical "sector," with a teaching hospital at its apex, might furnish one or at most two such individuals in normal times attached to the teaching hospital, while with wartime expansion there have sprung up in the sector four or five other centres each of which may at present contain two or three times as many casualty beds as its parent and each of which ought to be provided with a physical medicine specialist. In the extra-metropolitan "regions" the situation is even worse, and is being progressively aggravated by the withdrawal into the Army of ever greater numbers of medical men. This withdrawal threatens to render futile, owing to lack of candidates, a scheme for an intensive course of training of medical men in rehabilitation therapy set up under the British Emergency Medical Service. The desirability of such medical supervision, now officially

recognized, ought to be obvious; its virtual indispensability, however, is fully realized only after comparing centres where it exists with those where there is no such unified control.

The policy of the Ministry is, at any rate at present, not in favour of the setting up of rehabilitation "centres." After the war, however, it is almost certain that such institutions will be found necessary, and the present emergency might, if the individuals were available, lead to the equipment of a number of men and women with a training which would render them competent to supervise a form of therapy whose post-war establishment will represent a great and long-advocated advance in the treatment of injury and disease.

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REHABILITATION IN THE ROYAL AIR FORCE

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An air gunner of the Royal Air Force, a man of proved courage and determination, was admitted to a civilian orthopaedic hospital in November 1940, for the treatment of a torn and displaced semilunar cartilage. In August 1941, no less than ten months after admission, he was still in hospital and still totally incapacitated. Why was recovery so long delayed? What possible explanation could there be? The diagnosis had been correctly made. A skilful operation had been performed. No surgical complication had supervened; the wound had healed by first intention; there was no infection; there was no arthritis. Daily treatment had been continued in the massage department, but the muscles of the thigh were wasted and very weak. The joint had twice been manipulated under anaesthesia, but the range of movement was only half normal. The man's gait was slow and hesitant; he limped; he could not run; he had never tried to run. The medical officer blamed him because "he would not co-operate," because he was disinterested, depressed and resentful. It is true that he was depressed, but not without reason, for after ten months the incapacity was more complete than on the day of admission. He was disinterested because in his own words "nobody takes any notice and it looks as if it is hopeless." He was resentful because he could not believe that the fault was his. Had he not been told that "the nerve to his knee had been cut"?

He was transferred to one of the orthopaedic rehabilitation centres of the R.A.F. Medical Service. He saw the sky, the sea, the open spaces. For many months he had seen only the stone walls of hospital wards, the stone walls of massage rooms, the stone walls of many corridors. His new surroundings were different: there was a lounge and a writing room, tasteful decorations and flowers, a menu which was varied and excellent, an atmosphere of well-being

and contentment. After a few days he smiled. There was sometimes a sparkle in his eye. Within a week he sensed the spirit of optimism. It grew upon him and he was reassured. His difficulties were explained, and he was taught special exercises. He learned to walk and then to run. He became an enthusiast and worked hard. He worked in the gym, played on the fields, swam in the pool, cycled on the track. Time raced past, for he was busy. He attended lectures, played billiards and went to concerts. He became bronzed and fit. He laughed and was full of the joy of life. In seven weeks he returned to his unit and to full duty. He forgot about the "nerve in his knee."

Ten months — total incapacity; seven weeks — full recovery; that is the story of rehabilitation in one air gunner. But is this an isolated case from which no conclusion should be drawn? The answer lies in the records of industry, the files of insurance companies, the experiences of H. E. Moore, the investigations of the B.M.A. Committee on Fractures, the findings of the Trades' Union Congress, the reports of the Interdepartmental Committee on Rehabilitation, the publications of the Fabian Society, the reports of the Central Council for the Care of Cripples, the analyses of H. E. Griffiths, the papers of Kessler, Middleton, Watson-Jones, Cunningham, Levy, Nicol, Houlding, Malkin and others. These records show that the experience of the air gunner is not unusual. It is typical of the experience of many victims of bone and joint injury. In this country at this moment, there are scores nay hundreds of injured men, whose surgical treatment was concluded many months ago, but whose incapacity is still total because minor disuse changes remain, because confidence is lacking, because morale has been destroyed. Their bodies have been treated, but not their minds. The treatment of fractures has been concentrated on securing union of the fracture. No treatment has been directed to the tone and volume of muscles, the stability of joints, the circulation of limbs, the control of oedema, and the relief of adhesions. There has been no measurement and graduation of physical activity. There has been no attempt to continue treatment until the patient regained con-

fidence, and recognised for himself that recovery was complete. It has been assumed that the healing of a bone was followed promptly by the return of full function. It has been assumed that when a man was discharged from hospital he soon returned to work. But now that members of the services may not be discharged to out-patients and lost sight of, it is found that a simple cartilage operation may cause ten months of incapacity. We have long known that a Colles' fracture of the radius was united in five or six weeks, but not that this simple injury might keep a man off work for over six months. We knew that minor fractures of the ankle could be left unprotected after ten or twelve weeks, but not that they often incapacitated workmen for over a year. We never conceived that in one consecutive series of 276 men, there could be a wastage of no less than 168 working years. We have not realised that, stiffness, swelling, weakness and wasting may appear insuperable difficulties to many patients who, after all, are inexperienced, who fear that the weakness may be permanent, who are overwhelmed by the prospect of normal work with its strains and hazards, and who express their fears in the symptoms of "traumatic neurasthenia" and "malingering."

Six years ago, the British Medical Association and the Trades' Union Congress reported upon these facts, and recommended the development of rehabilitation services to accelerate functional recovery and to complete it. It was advised that rehabilitation should include (*a*) functional treatment in hospital wards by regular active exercise; (*b*) treatment in rehabilitation centres by organised physical and recreational activities with the object of overcoming residual disuse changes, restoring the confidence of patients in the completeness of their recovery, and bridging the gap between the exercises of a fracture ward and the stresses of normal work; and (*c*) vocational retraining for the very small proportion of men whose disability is permanent and who must learn a new trade. These recommendations have not yet been generally adopted. In a report just published on the Medical Supervision of Industrial Workers, it is regretted that "the country does not as yet possess a comprehensive

rehabilitation service." Of the civilian needs of the country it must be admitted that this is true. The Crewe, Greenwich and Mansfield rehabilitation centres are very important, but so limited that between them they treat only a hundred patients and apart from these centres, the development in Scotland of occupational therapy and the appointment by the Ministry of Health of an Advisory Committee, the provision of rehabilitation for civilians and industrial workers appears to be almost negligible. There is, however, a comprehensive rehabilitation service in the Royal Air Force. It has been developed in association with a considerable number of hospitals throughout the country, for the treatment of all types of injury, sustained by a large population of men, engaged not only in flying and operational activities, but in many forms of employment. The service has been in existence for two years, and it is now possible to review the experiences, to profit from the mistakes, and to assess the value of this treatment. Opinions which I provisionally submitted to the British Medical Association, the Interdepartmental Committee and the Royal Commission on Workmen's Compensation have been put into practice, and to a surprising degree those early forecasts have been confirmed. Experience has proved the value of organised treatment in the wards, the undoubted value of rehabilitation centres remote from fracture hospitals, the importance of patients actually living in the centres, the necessity for swimming pools, playing fields and open spaces, the vital significance of creating the right atmosphere, the need for individual supervision of treatment by medical officers, the smaller part to be played by physical training instructors, the impossibility of one medical officer treating more than fifty patients, the unimportance of remedial workshops and the limited value of occupational therapy and physiotherapy. Experience has proved conclusively that the demands of rehabilitation are not satisfied by "pepping up the massage department"; that it is very difficult and usually impossible to fulfil the requirements within the grounds and buildings of a hospital; that a rehabilitation centre without the right atmosphere is almost worse than no rehabilitation centre at all. A spirit of optimism, an atmos-

phere of enthusiasm, varied and continuous activities, and individual treatment by medical officers of the right type — these have proved to be the secrets of success.

Rehabilitation in Hospital Wards

The object of functional treatment is not only to cure, but also to prevent muscle wasting, joint stiffness and other disuse changes. The treatment must begin as early as possible. Every single patient in the ward has at least one special exercise to perform. The man with the fractured forearm exercises his fingers and shoulder. The patient with the fractured tibia mobilises his toes and maintains the tone of the muscles of the thigh. Every patient with a lower limb in plaster practises quadriceps muscle drill, even if the plaster extends over the thigh, or over the hip joint and trunk. The man with the fractured spine immobilised in plaster, turns on his face and develops the erector spinæ. Every patient with a disability of the knee joint is taught thigh muscle exercises before operation, and practises them immediately afterwards. Limbs which are not injured are also exercised, in order to promote general fitness, and to reduce the difficulties which arise when the man leaves his bed.

Exercise Leaders. — It is not enough simply to instruct a patient that he must exercise. If the exercise is to be of value it must be repeated over and over again, continued hour by hour, and practised persistently despite boredom and weariness. Rehabilitation does not begin with recreation and games; it begins with work and very hard work. It was found that an enthusiastic surgeon could change the spirit of a ward from one of complete lethargy and despair, to one of some activity and life, but it was quite impossible for him to maintain sufficient continuity and persistence of activity. He was engaged in the operating theatre, in the plaster room, in out-patients, and elsewhere. A trial was therefore made of appointing from among the patients one who was the exercise leader, who at every hour of the day called his colleagues to attention, and supervised five minutes of special exercise. In one ward, for example, a sergeant pilot with two fractured arms, two burnt hands, and ten

burnt fingers, inspired others by his own effort, and achieved a great measure of success. But patients selected for their eagerness and enthusiasm were often the first to get well and pass on, and moreover there was no uniformity in their qualities of leadership. The final solution, and the one which proved to be of the utmost value, was the posting to every fracture ward of a specially trained full-time rehabilitation orderly.

Rehabilitation Orderlies. — From the lists of nursing orderlies, groups of men were selected for trial, selected by reason of their personal qualities, their enthusiasm and drive and the respect they would command by former achievements in football, golf, physical training, ice skating, etc. They were trained and examined in the general principles of fracture treatment, given experience in two rehabilitation centres, taught the details of active exercises, constantly warned of the danger of passive stretching, and finally posted not as masseurs, not as quack practitioners, but as orderlies for the supervision of all physical and recreational activities. Their most important duty, under the instruction of the medical officers, is to teach every patient his specific exercise, and to see that these exercises are repeated hourly throughout the day, coaxing, urging and goading as may be required. Their work calls for patience and good humour; it is a healthy sign when an orderly is chaffed by his patients who call him "the muscle mechanic." They also teach patients how to walk in plaster without a limp. Almost every man who begins to walk in plaster takes a short cautious step with the injured limb, a hurried stride with the normal one, stooping with his face to the ground, and leaning heavily on a stick. An ingrained habit is soon established. Tuition is given by splitting the motion into separate, rather exaggerated movements, by emphasizing the equal length of stride, the equal pause on each foot, and the erect position of the head and trunk. Provided that no "walking iron" has been fitted, a patient in a below knee plaster, with the aid of a full length mirror, should learn within a few days to walk with a gait which is indistinguishable from normal. The secondary duty of the orderlies is to organise occasional sessions of general respira-

tory, trunk and limb exercises; to promote carpet making, needlework and similar activities; to encourage wireless observers in Morse tapping practise, communicating with each other from one end of the ward to the other; to introduce darts, tenniquoits and billiards in the recreation rooms and solarium; and to arrange simple medicine ball recreations in the hospital grounds. When these activities are fully organised, and when every single individual in the ward is concerned, each patient competes with his neighbour, a spirit of enthusiasm arises, and dullness and despair are banished. It must be emphasized, however, that recreational therapy, occupational therapy, and the therapy of intellectual pursuits, valuable as they are in creating atmosphere, do not, and never will supplant the need for deliberate hard work in mobilising joints, and developing particular groups of muscles. The dominant note of treatment is exercise, not recreation.

Treatment in Rehabilitation Centres

When the fracture has united and the plaster is removed, muscle redevelopment must be accelerated and intensified. It might be possible to achieve this in any hospital department or gymnasium by static exercises. But greater interest and enthusiasm, and therefore much more rapid progress, can be secured by the exercises of movement — running, skipping, cycling, swimming. It is obviously an advantage from the purely physical point of view, that treatment should be completed where there are playing fields and swimming pools, squash rackets and tennis courts, bowling greens and croquet lawns. But there are more subtle reasons for the development of rehabilitation centres remote from general hospitals. The patient whose infected compound fracture has been treated in hospital for many weeks or months, is satiated with hospital routine. A change of surroundings and open air, are no less important in his convalescence than good food and recreational activities. Moreover, the average man who lies in bed for many weeks, asking for this, ordering that and commanding the other, becomes the king of a little universe which revolves around him. Here lies the germ of

chronic invalidism. Both discipline and a new mode of life are necessary. Finally, nothing can be more certain than that patients whose injuries have been complicated by fears and depressions must be inspired by a spirit of optimism and enthusiasm and that complete removal from the hospital atmosphere is imperative. Every patient, no matter what his psychological type, derives benefit when treatment is concluded in a special rehabilitation centre.

Continuity of Treatment. — The R.A.F. Medical Service has adopted this policy. With the exception of patients with less severe injuries, who can return direct to their units, all are transferred when the stage of active surgery is passed, when wounds are healed and new unpadded plasters have been applied, when the position of fragments has been finally and accurately adjusted, and the union of fractures is taking place. Facilities for X-ray examination in or near the rehabilitation unit are obviously necessary, and a plaster theatre is also provided for changes of plaster and minor manipulations. But the centre must not become another hospital, and for all major surgical procedures the patient is referred back to the hospital in which he was originally treated. Although geographically separated, the fracture unit and rehabilitation unit are not functionally separated, and there has been no evidence of lack of "continuity of treatment," or imperfect "unity of control." Patients arrive at the rehabilitation centre with a sealed envelope enclosing a complete clinical record, with prints of relevant X-rays, clinical photographs, and detailed notes. At the centre there is a V.A.D. clinical secretary, trained on the same lines as the secretary at the fracture hospital, and also a radiographic printer. The notes are continued, later X-ray prints are incorporated, and if further treatment at the parent hospital is needed, the up-to-date clinical record accompanies the patient once more. Continuity is also maintained by interchange of medical officers and by regular visits of consultants from the fracture hospital to the rehabilitation centre.

Special Rehabilitation Centres. — It has been possible to serve the needs of a considerable number of general hospitals by a much smaller number of rehabilitation centres. Special centres are

available for officers, for airmen air crews, and for skilled technicians, but no attempt has been made to provide a different centre for each different industrial activity. In discussing civilian requirements, it has been suggested that the formation of a railwaymen's centre at Crewe, a miners' centre at Mansfield and a seamen's centre at Greenwich, implied the need for special centres for each type of industrial activity. This is not so. The same exercises, the same recreations, and the same atmosphere apply to the treatment of every case. The only variation, depending upon the particular physical requirements of each industry, lies in the length of time that treatment must be continued.

Location of Rehabilitation Centres. — The centres in which the necessary atmosphere has been most easily created are those developed in the enclosed grounds and buildings of an evacuated boys' school and an hotel, situated in the country, near the sand-dunes and the sea, but in reasonable proximity to the relaxations and amusements of pleasure resorts. The whole life of the patient must be controlled and adjusted, and this is possible only when sleeping quarters, recreation rooms, gymnasium, playing fields and swimming pool are included within a compact and self-contained unit. In one centre these amenities are scattered and there has been clear evidence of loss of control. The patient who is most in need of discipline, makes it his business to escape, and treatment has thereby suffered. In another centre the gymnasium and swimming pool are nearly one mile distant from the sleeping and recreational quarters, and the conditions are comparable to those of a non-residential centre where treatment is given only from 9 a.m. to 4:30 p.m. This difficulty has proved very great, and it has become clear that conditions can never be ideal until patients are actually in residence and under whole-time supervision.

Number of Patients Under One Medical Officer. — Treatment must of necessity be given by a medical officer and not simply by a physical training instructor. It is true that in the later stages of recovery, group exercises and games can be supervised by an instructor; but in the earlier stages, a patient who is timid and fearful

must have supreme confidence in the surgical judgment of his adviser. A physical training instructor is not in a position to reassure a patient that certain symptoms may be ignored, and to advise him that activity should continue despite discomfort. This reassurance is needed at the moment that symptoms arise, and not once or twice a week on the occasion of routine medical inspections. The medical officer must actually work in the gymnasium side by side with the patient, being prepared when necessary to spend half an hour, an hour or even several hours in the handling of one individual. He must become personally acquainted with him, search for his particular difficulties, and deal equally with psychological and physical handicaps. It is clear therefore that one medical officer cannot treat more than a limited number of men. Allowing for the proportion of patients who are in need of no special aid, and for those whose treatment can be completed by a physical training instructor, the maximum number is in the region of 50. This was the estimate originally made in the B.M.A. report and it is not an under-estimate. At times when the shortage of medical officers has been acute, attempts were made to increase the number to 75 or more patients, but at once there was a degeneration to mass treatment, and a loss of that intimate contact which is vital in accelerating recovery. It is believed that even the agreed maximum of 50 would have been too great, were it not that every patient is admitted whether his psychological difficulty is great or small, that most are admitted while still in plaster and before functional disturbances are profound, and that they have usually come from hospitals where rehabilitation has already begun. It must also be remembered that if treatment is successful the rate of turnover is rapid and new patients are constantly arriving. The average period of treatment ranges from only a week or ten days up to six or eight weeks. In all these circumstances the suggestion that one medical officer could supervise the treatment of several hundred patients, is obviously very far indeed from the truth.

The Rehabilitation Team. — The policy now adopted so far as limited man power will permit, is to allot to each group of 50

patients, a team consisting of one medical officer, one physical training instructor and one masseuse. These individuals are all selected for their personality, and for their ability to command respect and loyalty. The masseuse is engaged not only in electrotherapy and massage, but also in the teaching of exercises and the correction of limp. The physical training instructors take group exercises, games in the gym, a limited spell of marching and drill, and medicine ball or similar activities. One of them is of particular value in teaching special exercises, because not only are his muscles superbly developed, but he has an uncanny skill in the contraction of any one muscle independently of all others, including, for example, one rectus abdominis, the serratus magnus or the trapezius, a skill which fascinates and almost mesmerises patients into emulating the expert. At each centre there is an organiser of games — a famous Davis Cup coach for officers, and well-known professional footballers for airmen. The medical officer is responsible for every activity which concerns his own group of patients. The confidence of patients is promoted when this responsibility includes not only the supervision of masseuses and instructors, but all necessary surgical procedures such as changes of plaster, special clinical and X-ray tests, and manipulations under anaesthesia. Incidentally, valuable psychological information is often forthcoming during the recovery of a patient from pentothal anaesthesia. It is evident, therefore, that medical officers need not be experienced operators, but they must be well grounded in the principles of orthopaedic and fracture treatment, in the reading of X-ray films, in the technique of plaster and the art of manipulation. They have also been specially trained by Dr. H. E. Moore, the R.A.F. Civilian Adviser on Rehabilitation, who worked with them day by day, imparting experience which cannot be conveyed by word or letter but only by practice. Finally they have been encouraged to visit rehabilitation centres elsewhere, notably at Berry Hill where Mr. Nicol arranged a number of three-day demonstrations.

COMMANDING OFFICER. — (*"Administrative superintendent"*). — If a rehabilitation centre is sufficiently small, the medical officer

may also be the medical superintendent. But it is economically sound from the point of view of amenities, and psychologically sound from the point of view of atmosphere, to treat many units of 50 patients under one administration. The Commanding Officer of the whole centre may be a medical man, but not necessarily so. He must, however, be a man of unusual qualities, inspiring in his leadership, good humoured in his manner, and tireless in his zeal, a man who at one and the same time commands discipline and devotion. His duties include much more than simple administration; he has the power to create or to destroy the spirit which brings success.

Importance of a Large Gymnasium. — The most important item of equipment is a sufficiently large gymnasium, or for bigger centres more than one gymnasium. A vast covered space is required so that individual exercises, pulley and weight activities, couch work, tuition in walking, gymnastics, hopping and skipping, and organised games can all be pursued simultaneously and under supervision. Concentrated work on individual muscles, is of course, no less essential in the rehabilitation centre than in the hospital ward. This was advocated by Nicol, whose methods of controlling and graduating muscle contraction, and recording muscle power, have been used. But the boredom of one long day of activity must be relieved by limiting the duration of static exercises. There must be adequate space for handball, badminton, skittles, quoits and shuffle board, and for wall bars, climbing ropes, punch balls, bicycles and rowing machines. At one centre the gym space became unequal to the demand and when movement and progress exercises became increasingly limited, enthusiasm rapidly waned. The smallest useful gymnasium should measure 60 feet by 30 feet, this sufficing for not more than about thirty patients. The optimum size for a hundred patients is in the region of 150 to 200 feet long by 70 feet wide, the considerable length being desirable so that many activities can take place side by side across the width of the room.

Massage, Examination Rooms and Canteen. — Massage cubicles must open directly from the gymnasium or even be situated within it. An intervening corridor is unfortunate, and the formation

of a physiotherapy department at a distance from the gymnasium is a serious mistake because it encourages the wrong impression that physiotherapy and electrotherapy are independent and self-sufficient measures of treatment. Massage should not be an end in itself; it should be a means to the end of activity. The patient whose stiff joint has been baked, immediately exercises it in the gym; the man who develops aching and discomfort while working in the gym, retires for a period of massage; as the indications arise, there is to and fro movement of patients. Paraffin wax baths, whirlpool baths, radiant heat and diathermy are all useful provided only that the value of passive measure is put in proper perspective with the value of active effort. Similarly hot and cold showers and footbaths are important additions to the changing room. The medical officer's examining room where case sheets and X-rays are filed should also open directly from the gymnasium, because frequent clinical examinations must be made, and the confidential atmosphere of a consulting room is needed for the reassurance, firm handling or stern criticism of individuals. It should be easy for a medical officer to take a patient into his private room for two or three minutes, as a simple incident in the course of the day's activity, and with none of the formality of a routine inspection. Finally, space in the immediate proximity of the gymnasium should be devoted to the needs of occasional relaxation and refreshment at a canteen or milk bar. Every factor which attracts the patient to his work, and reduces the need for compulsion, is of value.

Playing Fields and Swimming Pool. — The routine in one of the centres has been to devote mornings to work in the gymnasium and swimming pool, and afternoons to croquet, golf, tennis, handball and squash racquets, with occasional tournaments for the "nearly fit," and some for the "not-so-fit." But this programme has tended to encourage patients in the belief that the day finishes at lunch time, and special exercises are very often needed for much more than half the day. It is better that gymnasium and playing fields should each be used, both in the mornings and in the afternoons. Moreover, general recreations and games must be organised,

and closely related to the requirements of the individual. He may begin with "standing tennis" or bowls, and graduate through croquet or approach putting, to fives or squash racquets. A swimming pool is invaluable, particularly for internal derangements of the knee where muscles must be redeveloped without weight bearing strain. One patient, for example, with an arthroplasty of the knee following an infected gunshot wound of the joint, was able to mobilise and stabilise his new joint by swimming, long before he was fit for gymnastic activities. Now, despite the handicap of a surgically constructed joint with a transplanted fascial lining from the opposite thigh, he is regularly flying bombers across the Atlantic and Pacific Oceans. Patients whose cartilages have been removed are expected to make a complete recovery, and be fit for every type of activity within six weeks of operation, and this is in marked contrast with the average period of disability when no rehabilitation and no swimming pool is available. Cycling is another non-weight bearing exercise of the greatest possible value in knee joint cases. Through the aid of the Red Cross of St. John, each rehabilitation centre has been provided with 20 bicycles, some fitted with a variable length of crank shaft by which to accommodate limited ranges of knee movement. Actually, complete stiffness of the knee joint imposed by a full length above knee plaster proved little handicap to one determined sergeant who took his place in the "cycle-polo" team. It might be assumed that, after a strenuous day of controlled activities every man would demand relaxation in the evenings, but even then the billiard table is in constant demand, and table tennis popular. There should certainly be periods of freedom for each individual to follow his own pursuits, but the arrangement of dances, concerts, debates and "brains-trust" meetings on one or two nights each week has proved desirable.

Occupational Therapy and Workshops. — The arts and crafts type of occupational therapy finds its greatest application in hospital wards where there are many idle hours to fill. Simple workshop activities such as carpentry, fret-sawing, model aeroplane construction and basket or rug making, are interesting additions to the

amenities of a rehabilitation centre, particularly during the winter months when outdoor activities are limited. But a remedial workshop is not a rehabilitation centre. Workshops, occupational therapy benches and massage cubicles are like medicine balls, climbing ropes and skittles, items of equipment which are sometimes useful but never indispensible. At one of the R.A.F. centres where skilled technicians are treated, fully developed technical training workshops are available for use during part of the day, the rest of which is devoted to closely supervised gymnastics and recreational activities exactly as in other centres. The intention was that patients who are capable of ordinary work for limited periods should use the workshops, and at the same time continue treatment. It was also intended that men might be tested from time to time under working conditions, in the same way that an air crew centre was equipped with a fuselage by which to test the physical ability of pilots. This combined rehabilitation centre and workshop is continuing experimentally but it is by no means certain that any advantage has been gained over centres without workshops. The one fact which is clear above all others, is that the provisions of a workshop alone, with arrangements for the surgical examination of patients once a week is a complete misunderstanding of rehabilitation. I have seen men dealt with in this way. I have seen them after six months. There can be no doubt that the danger of patients being buried in a workshop is even more grave than the former danger of patients being buried in a massage department.

Vocational Retraining

It has been argued that treatment in rehabilitation centres is unnecessary and wasteful, because all injuries fall into one of two groups: (1) those from which full recovery is possible without rehabilitation, and (2) those which cause permanent disability despite rehabilitation. But no surgeon would advance this argument, who had shared with me the experience of closely observing the recovery rate in a service assisted by rehabilitation where 90 per cent. of men returned to full duty, and at the same time, week after

week, reporting upon scores of workmen who are totally incapacitated, and for many months have remained totally incapacitated, by the disabilities which are so rapidly cured in rehabilitation centres. Even in men who remain permanently disabled, rehabilitation has not been wasted, because their permanent total incapacity is so often reduced to permanent partial incapacity. Indeed it is not possible to assess the degree of permanent disability with any accuracy until a patient has been treated and observed in a rehabilitation centre. It then remains the final duty of the rehabilitation medical officer (or the liaison officer working with him) to make contact with the employer and arrange an alternative form of employment, or to make contact with a retraining centre where the man will learn a new trade. The Ministry of Aircraft Production has co-operated with the R.A.F. rehabilitation service and arranged for the immediate employment in a suitable trade of men who are necessarily invalided, and in doing so, has accepted the recommendation of rehabilitation medical officers who have precise knowledge of the injured man's physical capacity. The teaching of new trades has long been undertaken at Oswestry, Leatherhead and Exeter and the Ministry of Labour is now engaged in introducing a more ambitious scheme of retraining. It is to be trusted that the complete rehabilitation service by which complete recovery is possible in over 90 per cent of cases, and which is an essential prelude to vocational retraining in the remaining 10 percent, will also be introduced.

REHABILITATION OF INJURED AIR CREWS IN GREAT BRITAIN

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Medical Officer in Charge of Rehabilitation of Orthopaedic Casualties at an R.A.F. Hospital

Flying accidents are associated with peculiar injuries, many of which are rarely encountered in civilian practice. When the flight of a machine is suddenly arrested by impact with the ground it is only to be expected that those portions of the body which are in contact with or are attached to the machine will be subjected to the greatest stresses. The incidence of injuries of the feet and legs is high because they are less well protected against missiles than the rest of the body, and the small bones of the feet are liable to be fractured by impaction against the rudder-bar. In the days when machines were not fitted with safety harness the skull was often smashed against the instrument panel. The safety harness has saved many lives, but is associated with another injury — compression fracture of the spine due to hyperflexion at the level of the retaining straps. Gunshot wounds produce a number of interesting peripheral nerve lesions. Gasoline has caused many cases of severe burning of the face, hands, and legs, for some of which tannic acid treatment has proved quite unsuitable. Internal derangement of the knee-joint is a frequent cause of disability, due to lesions of the menisci and of the lateral and cruciate ligaments. The treatment of these casualties aims at the restoration of complete or maximal function, and the criterion of treatment is the category of the patient when he returns to his unit. He may be fit for full operational or restricted flying duties or fit only for ground duty. Every effort is made to make him fit enough to take to the air again, and many patients who might be discharged to ground duty are kept in hospital until maximal function has been regained.

If function is to be restored in the shortest possible time muscular

wasting and joint stiffness must be prevented. Union of a fracture in perfect alignment means little to a patient until he has regained the synergic activity of his muscles, and recovery from paresis of a muscle group is of little avail if the joint which it activates has become stiffened. Muscles cannot be synthesized, and their power and tone can only be regained by voluntary contraction and relaxation. Progressive remedial exercises form a basis for treatment, but the willingness of the patient to contract and relax the affected muscles at all hours of the day, wherever he may be, is the real key to success.

The value of organized rehabilitation of orthopaedic casualties has already been established by such pioneers as Mr. H. E. Griffiths at Greenwich, Dr. H. E. Moore at Crewe, and Mr. E. A. Nicoll at Mansfield. Mr. R. Watson-Jones has stressed many times the importance of rehabilitation, and his endeavours have not been without result in the Royal Air Force.

General Organization

Having received the necessary surgical treatment in an orthopaedic hospital, casualties are transferred to one of several rehabilitation centres as soon as they have recovered sufficiently to become ambulant. The rehabilitation department attached to this hospital is contained entirely within a very large gymnasium, so that, having entered, patients have no occasion to leave until the end of the morning. The keynote of treatment is activity, in the form of progressive remedial exercises and games. The onus of recovering the function of an injured part is thrown on to the patient. The nature of his lesion is explained to him simply, and he is told what to do in order to overcome it. Passive treatment in the form of massage and electricity is avoided unless definitely indicated. By recording daily the range of movement of a stiffened joint with an angle measurer, or the strength of a wasted muscle group against the resistance of weights running over pulleys, the patient becomes interested in overcoming his disability and enthusiastic over his progress. Having gained his co-operation, it remains only to super-

vise his progress and to ensure that his activities are graduated. The progress made by every patient is recorded weekly in a folder, which has followed him from the R.A.F. hospital in which he received his initial treatment and which contains prints of the pertinent radiographs. This folder is subsequently returned to the surgeon who performed the initial operation.

The rehabilitation department is in the charge of a medical officer, who is assisted by a physical training officer, a sergeant, and three masseuses. The department is run in close collaboration with the sports officer, who organizes all kinds of games of a competitive nature for those in walking plasters as well as for those who are nearly fit. The gymnasium contains a small but adequate four-cubicled physiotherapy department, the medical officer's office, a milk-bar at which the patients obtain some compensation for their expenditure of energy, and cloak-rooms. The floor space, approximately ten square feet per patient, is divided into four parts: the two largest areas are used for the general remedial classes and for special remedial exercises, the third area is used for games, and the fourth is opposite the milk-bar and contains chairs and tables at which the patients may rest.

Every orthopaedic patient performs at least two sessions of special remedial exercises, mostly of a non-weight-bearing character, under individual supervision by a masseuse. When muscular tone is regained he joins the "nearly fit" class, in which he performs general remedial exercises of a muscle-developing nature and swimming, in addition to his special exercises, which he is encouraged to perform at every opportune moment throughout the day. Finally he graduates to the "fit" class and participates in all organized activities. The general remedial classes are run concurrently and last for three-quarters of an hour. They are followed by a ten-minutes rest interval and then by competitive games such as volley-ball; both classes then adjourn to the swimming-bath.

During the afternoon golf, tennis, swimming, and volley-ball tournaments are arranged by the sports officer, who is advised as to

what each patient should and should not do. It is not always appreciated that dancing has considerable remedial value.

Occupational therapy is not employed to any great extent, since it is considered that more improvement is made in the early stages of treatment by encouraging the patient to concentrate on overcoming his disability by working away at it all day long. In the later stages the patient's attention is diverted from his injured part by participation in competitive games. Patients do not undergo vocational training while at this hospital.

The Need for Individual Supervision

In the words of Dr. Moore: "A certain percentage of injured persons will work out their own salvation after receiving the necessary surgical treatment, with little or no help and without any special prolongation of incapacity. However, there will always be quite a fair percentage who will require something more if they are not to drift and greatly prolong their disabilities. This is due to many causes, of which the chief are failure to get over their earlier difficulties, all kinds of retarding psychological factors, apathy, a desire to escape return to their former duties, and so on. Consequently individual supervision of their progress is an essential part of their treatment."

A patient who is left to his own devices after receiving surgical treatment will quite naturally be fearful of exerting too much activity rather than too little. It is therefore most important that he should realize that the function of a plaster cast is not to prevent him from using an injured part but to enable him to use it to the greatest extent that is compatible with immobilization of the fracture. If the plaster is properly applied and remains intact it will immobilize the fracture whatever the patient may do. Supervision is necessary to ensure that the plaster does remain intact and comfortable and that the patient does make frequent use of every joint which is not necessarily immobilized.

Manipulation and arthrotomy are followed by effusion into the

joint and surrounding tissues, and if the effusion is allowed to persist adhesions and wasting will develop rapidly. By means of teaching the patient to contract the muscles which activate the affected joint before the operation, and by ensuring that he contracts them at frequent and regular intervals after the operation, the duration of incapacity is considerably shortened. Wasting and loss of tone of the quadriceps femoris muscle is of common occurrence and is apt to be associated with pain and effusion in the knee-joint if the patient performs too violent weight-bearing activity. This is because the lateral ligaments of the knee-joint were never intended to withstand strains in a mechanical sense but to evoke increased tone in the quadriceps muscle whenever they are subjected to tension. Should the quadriceps, "the guardian of the knee-joint," be weakened, the lateral ligaments may easily be stretched and cause effusion and pain, which is liable to keep the patient awake at night and is to be distinguished from stiffness on awakening, which wears off with exercise. Without supervision a patient with wasted thigh muscles may either be fearful of exerting sufficient activity to regain the strength and tone of the quadriceps or may exert too much weight-bearing activity, so that in either event the vicious circle of wasting and effusion will become chronic and incapacity is unnecessarily protracted. With supervision excessive muscular wasting is avoided and, by restricting activity to non-weight-bearing exercises until muscular tone is regained, the period of incapacity is minimal.

It is most important to treat the patient as well as his lesion and to ferret out any "fears" which he may hide in the back of his mind. A careless statement such as "he will never fly again," if overheard by the patient, may greatly retard his progress by destroying his will to recover. Daily observation of progress engenders optimism, and the progress made by others, in addition to suggestion by posters and by the staff, ensures co-operation from the patients. Compulsion is seldom necessary, and is avoided to the greatest possible extent because it tends to evoke an attitude of obstinate resistance. Before discharging a patient to flying duties it is important to ensure that

he has regained confidence in his ability to perform all normal activities. A patient who has regained full movement and muscular tone after excision of the patella may yet be fearful of running. Encouragement and participation in competitive games will overcome this natural phobia.

Physiotherapy

Physiotherapy is of great value for selected cases. It is a form of passive treatment and as such is given sparingly, because some patients are only too happy to lie at their ease on a couch and receive treatment which, for remedial purposes, is a poor substitute for their own activities. Warmth facilitates the movement of any joint by inducing hyperaemia and relaxation, and the only problem is how to direct the heat where it will do most good. A hot bath, a radiant-heat cradle, and a diathermy set each have their particular uses, but in the rehabilitation department only radiant heat is used to loosen up stiffened joints before starting remedial exercises. Faradism is used only to assist a patient to acquire the knack of contracting muscles that are very much wasted, and once he has learnt to do this the faradism is discontinued, because it is considered better to avoid passive treatment and to encourage the patients to regain muscular strength and tone by their own exertions. Galvanism serves to reassure a patient with a peripheral nerve lesion that the paretic muscles will still contract, and is also of some value for the dispersal of static congestion. An experienced masseur is able to loosen muscular adhesions by deep massage, but this treatment is seldom necessary if the patient has contracted his muscles at regular and frequent intervals throughout any period of necessary immobilization.

Patients perform their remedial exercises under the supervision of a masseuse, and this arrangement is found to be more satisfactory than to use a specially trained physical training instructor for exercises and restrict the masseuses to physiotherapy, because otherwise certain patients will tend to evade the physical training instructor for more pleasurable treatment at the hands of the masseuse. It is

probable that masseurs are more suitable for the treatment of non-commissioned ranks, but I believe that masseuses are better able to obtain the co-operation of young officers.

Fractures

For the purpose of rehabilitation, patients with fractures fall into two groups — those who are uniting and require immobilization, and those who have united and require remedial treatment to restore the strength and tone of their muscles and the movements of their joints. Obviously effective treatment of the first group will minimize the treatment required by the second group and will curtail the period of incapacity.

There is no really practical method of hastening the union of a fracture, and a month or a year may pass before union is sound, but this period can be minimized by completely immobilizing the fragments and stimulating their blood supply by muscular contraction. Incomplete immobilization must retard union by shearing across the developing callus which bridges the gap between the fragments. Repeated shearing of the callus will lead eventually to sclerosis of the bone ends, which is the cause of established non-union, and the pseudarthroses which reside on the shelves of our pathological museums.

To immobilize a fracture of the shaft of a long bone it is necessary to fix the joints at each end of the bone in a degree of flexion sufficient to prevent rotation occurring between the fragments. Complete immobilization of a fracture can only be ensured by internal fixation with a bone graft or a plate, and it is probable that a plaster cast alone seldom effects complete immobilization because of the interposition of soft tissues between the plaster and the bone. Union of a fractured tibial shaft may be slightly delayed when treated in an above-knee walking plaster; nevertheless if the patient walks properly, rocking from the heel on to the forefoot and pushing off with his toes, there will be a minimal amount of muscular wasting and stiffness when the plaster is discarded. This is because venous drainage from the dependent limb is maintained by inter-

mittent muscular contraction, and static congestion, which causes partial anoxaemia, rapid muscular wasting, and adhesion formation, is prevented. In the treatment of any fracture just as much attention should be paid to the soft tissues as to the fracture. For movement is effected by muscles: the bones form only a frame, and our object is to restore function.

To adapt a leg plaster for walking purposes our practice is to use a wooden heel, which is laced on to the plaster by means of a canvas

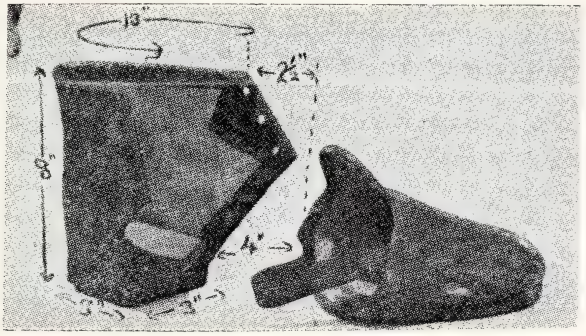

Fig. 1.—Walking-heel and toe-cap used to adapt a leg plaster for walking purposes. This heel affords sufficient stability for the patient to be able to balance on his injured limb, and encourages heel-toe movement.

"spat" and a toe-cap (Fig. 1). The heel is hollowed out on its upper surface, to which is glued a layer of half-inch sorbo rubber. The heel and toe-cap are standardized so that they may be used on almost any plaster. They enable a patient in a below-knee plaster to walk so naturally that a casual observer would not notice anything wrong with him; and if the heel of an above-knee plaster is raised with a three-quarter-inch plaster slab before applying the walking-heel, and the heel of the shoe on the sound leg is raised with a three-quarter-inch wooden block, the patient is able to walk without sticks or crutches with an almost natural gait. Unlike the walking-iron, the wooden heel affords sufficient stability for the patient to be able to balance on his injured limb. This stability gives him confidence and encourages him to rock forwards on to the toes instead of pivoting his foot outwards on the stud of the iron as he steps

forwards. Attention to the detailed construction of a walking plaster is well repaid, because if a patient actively contracts the flexor muscles of his toes while walking and is able to walk without limping muscular wasting and stiffness are minimal when the plaster is discarded and function is rapidly regained. Several weeks of incapacitation of a patient who is being treated in an above-knee walking plaster may be prevented by mobilizing the knee-joint two weeks before discarding the plaster. This is not done by replacing the above-knee by a below-knee plaster, but by reinforcing the anterior part and cutting away the posterior part of the above-knee portion of the plaster so that the patient is able to sit and swing his leg, thereby regaining flexion movement. For walking, the plaster is bound to the thigh with a crêpe bandage. So long as the knee-joint is splinted in the flexed position no rotation can occur at the fracture. After discarding the plaster full movement of the knee-joint is regained by non-weight-bearing exercises, flexion and extension, rowing and bicycling, until the strength and tone of the quadriceps muscle are regained. Full movement of the tarsal joints and ankle-joints is usually regained within a week as the result of walking and remedial exercises, and the patient is not discharged until his calf muscles are powerful enough for him to be able to raise himself on to his forefoot without assistance.

After discarding a walking plaster the extremity of the limb will become swollen during the daytime unless the soft tissues are supported by an elastic or some other kind of bandage, and this tendency to swell will persist until sufficient tone is regained in the calf muscles to maintain the venous circulation of the limb. This is explained to the patients, and they are instructed to avoid standing and always to elevate the limb when sitting so that it drains by the action of gravity. Congestion is the prelude to adhesion formation, and while it persists muscular tone will not be regained. This is but one reason why it is important to maintain the tone of the calf muscles throughout any period of necessary immobilization.

Compression fracture of one or more vertebral bodies, as the result of hyperflexion of the spine, is a common injury among air

crews who have crashed. Many of these cases are unassociated with injury to the spinal cord, and the patient is able to walk away from the site of the crash, although he complains of a constant aching pain in his back. Cases that require transportation should be rolled on to a stretcher and carried flat, because hyperextension of an injured cervical spine may cause dislocation, and hyperflexion of the lumbar spine may increase the compression. Compression fractures can usually be decompressed by the pull of the anterior longitudinal ligament which occurs with hyperextension of the spine by the two-table technique. Comminuted fractures can usually be realigned very satisfactorily by this method, but they unite slowly and extension should be maintained for at least five months in a Watson-Jones plaster jacket. Neurological examination often reveals symptoms referable to root compression in cases of compression fracture of the spine. These symptoms are relieved by extension of the spine but will recur if immobilization is discontinued too early. Premature mobilization of a fractured vertebral body may be followed by progressive wedging and absorption of bone. No harm is done by unnecessary immobilization of the spine provided that the tone of the musculature is maintained, but premature mobilization may produce chronic symptoms.

Activity is an essential part of the treatment of these patients throughout the period of immobilization. Extension exercises are performed daily and a progress chart is kept of the weight which each patient is able to raise over a pulley by extending his spine. If the fracture is firmly consolidated and the power and tone of the back muscles are maintained, these patients are able to return to flying two weeks after discarding their spinal jackets.

Manipulation

Manipulation is of value for increasing the range of a stiff joint that has become stationary and for relieving the symptoms in a joint that gives rise to pain at one extreme of its range of movement.

Manipulation of a stiff joint is indicated only when the surgeon is satisfied that as the result of his own unaided activities the patient

is unable to gain any increase in the range of movement of the joint and that the joint has not been subjected to any form of passive stretching. The manipulation should be performed under full surgical anaesthesia, so that the muscles are completely relaxed and the surgeon is able to feel the resistance which he has to overcome. The operation should not be performed until the adhesions have become crisp and avascular so that they snap easily and are followed by a minimal amount of reaction, and manipulation should therefore not be repeated at intervals of less than two months. No matter how great the discomfort the patient should begin active unaided movements of the joint as soon as he has recovered sufficiently from the anaesthetic, and should repeat these movements at hourly intervals. He should retain 75% of the increase gained under anaesthesia and recover the remainder subsequently.

Flexion of the knee-joint may be limited by adhesions between the patella and the femur, in which case manipulation of the joint will very probably fracture the patella; the latter should be mobilized before manipulation is attempted. Before manipulation a stiff joint should be radiographed to exclude bony block. Every effort is made to obtain at least 90 degrees of flexion of the knee-joint, and radio-ulnar movement is absolutely essential for the management of an aircraft.

Manipulation of a joint in order to relieve pain at one extreme of its range of movement should not be attempted unless the manipulator has an intimate knowledge of the normal movements, both voluntary and involuntary, of the affected and neighbouring joints. Adhesions resulting from prolonged stasis are usually broken down by the patient's own activities, but occasionally pain may persist which can be localized to one joint and one particular movement. Focal infection, if present, should be eradicated before manipulation is attempted.

Derangement of Joints

The stability of any joint is dependent upon two factors — the shape of the articular surfaces and the strength and tone of the

muscles which activate the joint. Dislocation of the shoulder-joint is a not uncommon injury among air crews. This joint depends almost entirely for its stability upon the strength and tone of the muscles which surround it, and unless the tone of these muscles is fully restored dislocation is liable to recur. A surprisingly large proportion of these injuries are associated with nerve lesions, due presumably to the violence of the dislocating force. The knee-joint is sometimes dislocated. One patient who ruptured the internal lateral ligament and both cruciate ligaments regained 100 degrees of flexion movement and the joint was completely stable unless he was caught off his guard, so that he was able to run and to play games, and this was because he regained excellent tone and great power of the quadriceps femoris muscle. Rupture of the external lateral ligament is sometimes associated with injury to the common peroneal nerve.

Decrease in the range of movement of a joint by shortening of muscles or their tendons may arise from prolonged splinting. This may result in flexion of the fingers when the wrist-joint is extended. The wrist must be stabilized by a plaster splint, and the fingers can then be slowly extended by the pull of elastic which is stretched between a wire frame and stalls worn on the fingers (Fig. 2). The patient is encouraged to flex the fingers at frequent intervals against the pull of the elastic, and as he relaxes the flexor tendons are stretched.

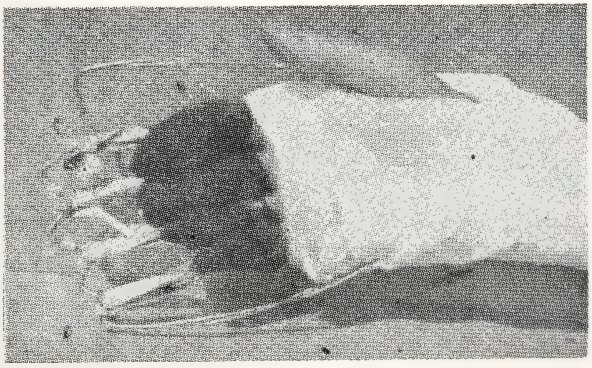

Fig. 2.—Extension splint to overcome contracture of flexor tendons.

The After-treatment of Burnt Hands

The rehabilitation of patients with burnt hands requires much patience and perseverance. Provided that the tendons and joints of the fingers have not been destroyed, the degree of recovery that is possible may exceed all expectation. The first thing is to assure the patient of this, and the second is to see that he works away at his stiff joints all day long. Whatever the initial treatment has been after burning, the skin is usually very thin and tender and sweats profusely. The stiffness is due to general adhesion formation around the tendons and joints of the fingers, and is caused by the initial reactionary oedema. The fingers are usually straight as the result of splinting. Movement is regained by immersing the hand in olive oil or in paste made with fuller's earth, which is heated to a temperature of 110° F. for two sessions of fifteen minutes daily. The patient is encouraged to squeeze a piece of rubber sponge or a ball while his hand is being heated. For the rest of the day he wears a detachable splint which dorsiflexes his wrist, and a glove to the finger-tips of which are attached lengths of elastic that are tied around a hook in the splint (Fig. 3). The constant pull of the elastic tends to flex the fingers, and the patient is encouraged at all times to oppose this by extending them. Treatment may take many weeks, but to regain the use of a hand justifies any amount of trouble.

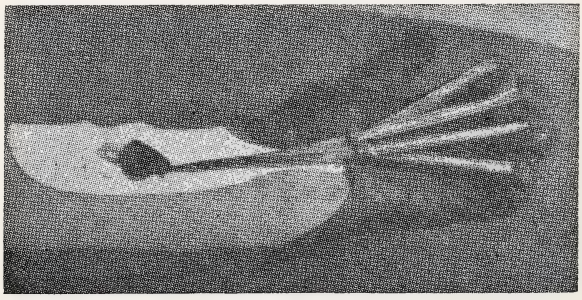

FIG. 3.—Flexion splint to overcome stiffness after burning.

Summary and Conclusions

In this paper the principles underlying the rehabilitation of injured air crews are described. Orthopaedic casualties are transferred to a rehabilitation centre after having received necessary surgical treatment in an orthopaedic hospital. Some of these would probably work out their own salvation without further supervision, but others would certainly prolong their incapacity unnecessarily. These casualties are therefore kept under almost constant supervision in order to restore maximal function and make as many as possible fit for further flying duties, and also to curtail incapacity.

Each patient is studied individually, for with his co-operation graduated remedial activity will restore function more rapidly than any form of passive treatment. Muscular wasting and stiffness, associated with immobilization, are prevented to a great extent by active contraction. A fracture is no reason for neglect of the soft tissues.

The criteria by which successful rehabilitation is judged are: first, the category of the patient on returning to duty; and, secondly, the time that he takes to regain function. Figures are as yet inconclusive, but 16% more patients were discharged to flying duties during the first six months that this department was working than during the six months before it opened.

REHABILITATION OF THE CHRONICALLY DISABLED WITH SPECIAL REFERENCE TO THE USE OF PHYSICAL MEASURES

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The problem of rehabilitation of the disabled is one which naturally should absorb the interest of the military physician, for in times of war such a problem becomes acute.

During and after the World War it became apparent that physical and occupational therapy played an extremely important part in rehabilitation of the disabled. Hansson[4] has pointed out that if we survey the development of medicine that has occurred during the last fifty years, it becomes apparent that the first twenty-five years of this era were dominated by the teachings of Osler, which stressed diagnosis, whereas during the last twenty-five years much more attention has been devoted to therapeutics.

Cotton[1] pointed out that "During the War our returning soldiers were given a care in convalescence that was wiser and broader than we have been accustomed to and was carried out with an extraordinarily high average of efficiency." He continued, "No department of the army medical machine worked better than the department of physiotherapy. From the first draft of the plans by Colonel Brackett and myself in the early summer of 1917, through the work of organization under the Surgeon General and the building up of a machine (largely by Major F. B. Granger under Colonel Frank Billings) the picking and training of the personnel and the work itself progressed as originally planned. . . . Highly trained women of real quality were picked out, registered, and put in service. . . . Certain schools offered intensive course from six to twelve weeks . . . so far as possible, they were given further clinical training

under Major Robert W. Lovett . .. it is significant that of about 2,000 applicants only about 815 were chosen. . . .

"Colonel Frank Billings has said that every hospital needs a physiotherapy department just as much as an operating room. Certainly no hospital which treats industrial or other injuries can produce first-class results, within a reasonable time, without provision for such work."

Despite the excellence of the rehabilitation during and after the World War and its undoubted influence on the development of physical therapy in the civilian hospitals, there was later a period of regression so that in 1936 Vance[9] stated: "It has become the prevailing mode with many of us to adopt a somewhat scornful attitude toward physiotherapy, taking its help for granted, and yielding it faint praise in return. This is a reaction from the boom years. In the military hospitals, during and after the war, physiotherapy reached its zenith."

At the moment, we are just beginning to learn to apply physical measures in a scientific and rational manner. We are now learning to use elaborate apparatus only when it is of proved value and we are tending to apply the simpler physical measures in rehabilitation whenever possible.

Stevens[8] has pointed out that "Early, the trouble lay in the tendency to utilize impressive but inefficient apparatus with little thought of the pathology present or the physiological effect of the modality in use. In the post-War period, with a wealth of clinical material, physical therapy, under government sponsorship in rehabilitation centers, reached a much more rational status." Today I believe that the use of physical measures in rehabilitation is even better rationalized than it was during the World War.

Apparatus

LIGHT. — During the World War part of the stock physiotherapeutic equipment of each reconstruction hospital was a number of hand light applicators.[2] These hand light applicators often contained a so-called infra-red unit very similar to the heating unit used in

household heaters. Today we know that these hand lamps are inefficient unless supplied with a rather expensive stand and that the handle may be replaced easily by a small inexpensive clamp which will fasten to the side of a bed or to the back of a chair. We know that the so-called infra-red units, although producing a great deal of sensation of heat on the surface of the body, do not elaborate rays which will penetrate deeply into the skin.

The penetration of radiation from a black body radiator such as the "infra-red unit" is never more than 1 or 2 mm. If in the same cup-shaped reflector a 250 watt carbon filament or tungsten filament lamp is substituted, such radiation will penetrate to a slightly greater depth (variously estimated up to 1.5 cm.). This radiation will produce a much greater degree of hyperemia than the black body radiation with less tendency to cause blisters.

Today the old-fashioned baker used routinely in army reconstruction hospitals and still of considerable service has been replaced to some extent by the large luminous heater consisting of an oversized cup-shaped reflector containing a 1500 watt tungsten filament bulb. Today the various types of ultraviolet lamps have been greatly improved in construction and new types of local applicators have been developed.

HEAT. — During the World War, in addition to the various lights and bakers used for the local application of heat, large cabinets called electric light cabinets were standard equipment in all reconstruction hospitals. In these cabinets the patient sat in an erect position and was heated for brief periods of time up to fifteen minutes. Today the modern fever cabinet, in which the patient is treated in a prone position and in which there is very accurate control of temperature and humidity, has proved to be a vast improvement over the old electric light bath cabinet. In these modern fever cabinets we are able to give treatments for ten or twelve hours, or even for greater lengths of time in certain cases.

During the World War the old-style conventional "diathermic" machine was used when it was desired to heat the deeper lying tissues of the body. Today short wave diathermy machines are avail-

able which produce deeper and more uniform heating of the local tissues of the body than did the conventional types and the simple application of hot paraffin has proved efficacious in the rehabilitation of certain traumatic lesions.

ELECTROTHERAPY. — Today the modern sinusoidal machine and the mechanically operated Morton Smart machines have replaced to a large extent the Smart-Bristow coil used during the World War.

HYDROTHERAPY. — The whirlpool bath used routinely during the World War has been improved and modified and today portable models are available. The continuous bath used routinely in reconstruction hospitals has been supplanted by the Hubbard tank or by the therapeutic pool.

EXERCISE. — The old-style Zander apparatus which was expensive and which limited exercises to certain standardized movements applied by the apparatus has become entirely obsolete. Today the skilled technician in physical therapy is able to give carefully graduated free exercises permitting the patient to perform any degree or range of movement required.

MASSAGE. — Today technicians skilled in physical therapy having years of experience in our civilian hospitals are able, under medical supervision, to give professional massage of a very high order.

OCCUPATIONAL THERAPY. — Occupational therapy has continued to develop since the World War and technicians skilled in occupational therapy working in elaborately equipped departments have developed the functional aspects of curative occupational therapy to a higher status than ever before.

Personnel

If one reads the section on Physical Reconstruction in the War Department's report on the Medical Department in the World War,[2] he cannot fail to be struck with the terrific problem that faced the men who developed the reconstruction service. At that time, physicians specializing in physical therapy were practically unobtainable. Technicians trained in physical therapy and schools for training technicians in occupational therapy did not exist.

Orthopedists, roentgenologists and internists were chosen and were trained in the field of reconstruction. Aides in occupational therapy and in physiotherapy were trained by giving short intensive courses.

Today there are many physicians who specialize in physical therapy. One-year internships in physical therapy are now offered to medical men in the Michael Reese Hospital in Chicago and in Stanford University in San Francisco; several years ago, three-year fellowships in physical medicine were inaugurated at The Mayo Clinic. The physicians trained in these special courses should be of great value in case there is a need for establishing services for military rehabilitation.§

If war should come in the future, it would not be necessary to train civilian aides. The aide in physiotherapy and occupational therapy as known in the period of the World War can now be supplanted by the technician from our civilian hospitals trained in physical therapy and in occupational therapy. The Council on Medical Education and Hospitals of the American Medical Association has established standards for and has approved thirteen schools for the training of technicians in physical therapy,* and a new course of this type has just been established here at The Mayo

§ With the coming of war it has been found that the supply of trained physical therapy physicians is still inadequate and emergency training courses had to be established at the Mayo Foundation. As of March 1943 fifty-one military physicians, forty-seven Army medical officers and eleven Navy medical officers had been trained at the Mayo Foundation, in these emergency courses on physical therapy.

* Schools for technicians in physical therapy conforming to the standard adopted by the American Medical Association in 1936:

Children's Hospital, Los Angeles, Calif., John C. Wilson, M.D.
Stanford University Hospitals, San Francisco, Calif., W. H. Northway, M.D.
Walter Reed General Hospital, Washington, D. C., Major W. W. McCaw, M.D.
Northwestern University Medical School, Chicago, Ill., J. S. Coulter, M.D.
Bouve-Boston School of Physical Education, Boston, Mass., Howard Moore, M.D.
Harvard Medical School, Course 445, Boston, Mass., F. R. Ober, M.D.
Boston University, Sargent College, Physical Education, Cambridge, Mass., Prof. E. Hermann, Dean.
St. Louis University School of Nursing, St. Louis, Mo., A. J. Kotkis, M.D.
University of Buffalo, Buffalo, N. Y., G. G. Martin, M.D.
Hospital for Ruptured and Crippled, New York City, K. G. Hansson, M.D.
D. T. Watson School of Physiotherapy, Leetsdale, Pa., Jessie Wright, M.D.
College of William and Mary, Richmond, Va., Committee on Physical Therapy.
University of Wisconsin, Madison, Wis., E. A. Pohle, M.D.

Clinic. Four schools for the training of technicians in occupational therapy also have been approved.†

In the schools for technicians in physical therapy, graduate nurses or individuals who have obtained a B.S. degree in physical education at a recognized school are given additional training in the technic of physical therapy for one year. A registry for technicians in physical therapy has been established and more than 500 trained technicians have already been registered.

In the schools for occupational therapy individuals who have had two years of college training are given an additional course of three years in occupational therapy. These individuals will be of inestimable value in civilian and military rehabilitation of the future.

Departments

The men who were faced with the problem of establishing a service for rehabilitation during the World War found practically no civilian hospital departments available. By 1931 there were in the United States 2236 departments of physical therapy as compared with 4523 departments of roentgenology;[6] although more recent figures are not available, we know that in the past seven years many new departments have been established.

Disabling Conditions Amenable to Physical Treatment

If one may draw a comparison between the disabilities that occur in present-day civilian life and those which are likely to be encountered in military life among the youthful enlisted personnel, the figures of Hilleboe[5] should be of value. Recently he stated that, "From an analysis of the cases under twenty-one years of age in the central registry (of the State of Minnesota) it has been determined that the cause of the 8300 disabling conditions are distributed

† Occupational therapy schools are the Philadelphia, St. Louis, Boston and Milwaukee-Downer.

Since this article was written, and as of March 1943, the number of approved schools for physical therapy technicians has increased from thirteen to twenty-four; and the number of approved schools for occupational therapy technicians has increased from four to nine. The demands of total war have necessitated this great expansion of our national training program.

in arbitrarily classified groups as follows: accidents, 11 per cent; anterior poliomyelitis, 20 per cent; arthritis, 2 per cent; cerebral palsies, 14 per cent; congenital deformities, 25 per cent; muscular dystrophy, 1 per cent; osteomyelitis, 4 per cent; rickets, 5 per cent; scoliosis of unspecified etiology, 1 per cent; tuberculosis of bones and joints, 3 per cent and a miscellaneous group, 14 per cent."

If these figures are analyzed, it is immediately apparent that the use of physical and occupational therapy, as developed during the World War and as elaborated on since the World War, will be of great value in the rehabilitation of many of these disabilities.

The rehabilitation of various types of orthopedic cases is one of the most important phases of the work of a department of physical therapy. Goldthwait[3] has said that, "An operation upon a bone or joint may be technically most perfect, but unless the performance is executed with reference to later usefulness or unless measures having to do with the restoration of function are instituted as soon as possible after the healing of the wound, a result that might have been perfect may, from the point of view of function, be very poor.

"In the American army results of just this sort led to a very considerable number of men coming back to the rear, reporting not only unsatisfactory results from the point of view of the man, but equally unsatisfactory from the point of view of further usefulness of these men to the army. A similar condition had resulted in the first two years of the war in England where the great numbers of wounded men had finished their surgical treatment with such unsatisfactory functional results that it became necessary to institute measures for the correction of these conditions on a very large scale."

Goldthwait further stated that, "The recognition of the corps of reconstruction aides and the fact that these aides have been assigned not simply to the hospitals in the remote rear but have been gradually assigned to hospitals with the army in the front is indication of the extreme to which the principle of the early application of measures having to do with the ultimate function has been applied."

Unquestionably, physical therapy was of great value in the restoration of function during the World War and in its present state of development it would be of still greater value. One may well conclude with Malkin[7] that physical therapy, "particularly that aiming at re-education, has a most important part to play in the treatment of injuries. It should be arranged, however, so that there is no interference with continuity of treatment, and it should be carefully supervised. In many cases its usefulness would be increased by association with a rehabilitation workshop."

As Stevens[8] has pointed out in regard to physical therapy, "By far the most valuable service which it renders is in the preservation and restoration of joint function."

With regard to the treatment of fractures, Wilson[10] stated that the chief principles of the treatment of fractures are "First, restoration of anatomic form as soon as possible after injury; second, maintenance of alignment and fixation of the fracture during the period of healing; third, institution of measures to overcome the circulatory disturbance and to maintain and develop function beginning at the earliest possible moment after injury and continuing until complete recovery is obtained."

He further stated: "The only measures at our command capable of accomplishing this purpose belong to the domain of physical therapy and they should be included just as regularly in the treatment of fractures and employed with the same skill as are reduction of the fracture and splinting to maintain alignment."

The use of physical and occupational therapy plays perhaps the most important part in the rehabilitation of the individual disabled by arthritis and today, as during the World War, these departments are of great value in the rehabilitation of individuals who have had amputations, dislocations, injuries of peripheral nerves, or other traumatic lesions.

In addition, in recent years fever therapy, as utilized in our hospital departments of physical therapy, has become an important adjunct in the treatment of gonorrhea and chorea and very recently

we have obtained evidence that it may be of value in the treatment of undulant fever, all of which diseases may be extremely disabling. In cases of gonorrhea and particularly in cases of gonorrheal arthritis, in which disability is so frequent, we now recommend that sulfonamide therapy be tried first. If the patient fails to respond to sulfonamide therapy alone, as is true in at least 10 per cent of the cases, we now use a combination of sulfonamide and fever therapy. Our procedure has been to give the patient 80 grains (5.2 gm.) of sulfanilamide a day for two days and on the third day we have given the patient fever therapy for a period of ten hours at a temperature of 106.5 to 106.8° F. (41.4 to 41.6° C.). Of the first thirty patients treated in this fashion not one failed finally to obtain negative cultures, in spite of the fact that all of these patients failed to respond to sulfanilamide therapy alone. We believe, therefore, that this procedure offers promise of being extremely valuable in certain cases of gonorrhea.

Our studies on fever therapy in cases of chorea indicate that fever therapy is frequently of value in causing disappearance of choreiform movements and in bringing about rapid clinical improvement. Our early studies of cases of undulant fever indicate that about 80 per cent of our patients will respond well to fever therapy.

Summary and Conclusions

Rehabilitation of the disabled reached a new zenith of development during the World War. The remarkable work done by the Division of Physical Reconstruction during the World War stimulated the development of physical and occupational therapy for the rehabilitation of the disabled in civilian practice. Fortunately, these fields have developed with extreme rapidity in recent years so that, at present, civilian institutions are better equipped than ever before to rehabilitate those who are crippled by disease or injury. In case of a future military emergency the well trained medical men specializing in physical therapy and the technicians of the present generation, highly trained in occupational therapy and physical therapy by using improved apparatus and equipment will be able to meet the

needs for rehabilitation of the disabled with much more efficiency than has ever been possible in the past.

Credit must be given to the far-seeing medical leaders in the United States army who organized the Division of Physical Reconstruction and who gave the first impetus to the remarkable development of this interesting and fascinating branch of the medical practice.

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HYDROTHERAPY AS A MEANS OF REHABILITATION

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Whatever the results of our war-time organization may have been in other branches of physical medicine, so far as hydrotherapy is concerned provision of facilities has been negligible. Furthermore, institutions which had specialized in hydrotherapy have been requisitioned for other purposes and their trained staffs dispersed in consequence. In war-time there can be no justification for reserving or diverting personnel and apparatus for a form of treatment which would not yield commensurate results and we may therefore consider first of all those conditions in which there is a need for hydrotherapy — that is to say with requirements which cannot be met so adequately by other means. One requirement which will most obviously increase as the war progresses is the treatment of traumatic conditions. The second in order of urgency in war-time is the treatment of rheumatism, arthritis and allied conditions. Lastly, we may consider the use of hydrotherapy in general rehabilitation of patients with organic or functional disease, or both, which have been found by long experience to benefit by the hydropathic regime.

Traumatic and Surgical Cases

As regards traumatic and surgical cases generally, the first essential for progress is much closer cooperation than at present exists between surgeons, particularly orthopædic surgeons, and practitioners of physical medicine, including hydrotherapists. Although patients in our spa hospitals receive the benefit of orthopædic advice and treatment, I know of no orthopædic institution in Great Britain which has a hydrotherapy department. For the practitioner of physical medicine periodical visits to the operating theatre to see the inside of living joints, eroded bone and cartilages, osteophytes, loose

bodies, tough adhesions and even protruded intervertebral disks, remind him that physiotherapy has limitations which can be more readily appreciated by this resort than by study of radiograms or by post-mortem examination. For the surgeon it is instructive to see how spasm can be abolished, œdema and inflammation dispersed and function restored by moist heat in the form of whole body or partial baths, packs and poultices, douche massage and, perhaps best of all, by the warm immersion bath with the hot undercurrent douche. It is certain that unless one has seen this treatment applied one cannot fully appreciate its efficacy and the difference in its effects as compared with those of the ordinary hose douche when not applied under water. Obviously one cannot apply certain kinetic forms of hydrotherapy to an unhealed surface, but thermal immersion might be used with benefit much more frequently than it is at present. After all the bath treatment of burns is not new and the recent Bunyan bag treatment, while making use of chemotherapy, is fundamentally a bath treatment. A memorable and instructive account of the salt bath treatment of burns from the patient's point of view is given by the anonymous R.A.F. author of *I Had a Row with a German.*

Hydrotherapy and Orthopaedics. — For use in orthopædic cases the main purpose of hydrotherapy is to restore movement, allay pain, improve the general and local circulation of blood and lymph and thus bring about those changes which are aids to healing and normal function. In a large proportion of cases massage and active and passive movement are necessary accompaniments. Ordinary massage may be given before or after baths, but massage in connection with hydrotherapy requires special training, not only to acquire skill and precision in handling hoses and regulating valves, but because the technique of wet massage differs from that of dry massage.

Equipment. — As regards equipment much can be done with improvised or very simple apparatus, but when any permanent arrangements are contemplated sound guidance is available from American clinics. Coulter, in the *Year Book of Physical Therapy*

(1941), says that the most important physiotherapeutic equipment for a general hospital concentrating in orthopædic work is one of three types of tanks designed for underwater exercises: (1) A large pool in which the technician may work in water with the patient; (2) A pool from three and a half to four and a half feet deep, eight by fifteen feet in external dimensions, in which the patient may walk while the technician follows around outside the pool; and (3) A Hubbard tank in which the patient can exercise only in a recumbent position.

The efficacy of pools for underwater manipulation and movement is greatly increased by the addition of the simple apparatus for undercurrent hose douching, namely, a hose leading from a mixing box to provide temperature control, an overflow pipe leading from the level of the surface of the bath to prevent overfilling, and a sprinkler pipe round the top edge of the bath through which cold water can flow in to prevent undesirable thermal effects from overheating of the bath while the hot undercurrent douche is being applied. In addition to tanks for manipulation, a douche massage table, hoses for alternate hot and cold douching, a steam cabinet, a whirlpool bath, a paraffin wax bath and materials for preparing packs and poultices should complete the equipment for the treatment of traumatic cases.

The Rheumatic Diseases

Experience of the treatment of rheumatic diseases in both private and hospital spa practice has convinced me that hydrotherapy is the most useful form of physical treatment in these conditions and in particular that at all stages of rheumatism and arthritis moist heat is generally more efficacious than dry heat. Since the outbreak of the war, and owing to the requisitioning of a much larger and fully-equipped institution, I have had charge of only a small hydropathic hospital with twenty-five beds, at which a small number of out-patients attends. The cases are mainly of the rheumatic type. The only treatments available are immersion baths of the ordinary domestic shape, general and local steam baths, contrast baths, hot

and cold douches, packs and fomentations, linseed and mustard bran poultices and massage. The results obtained with the above very limited armamentarium confirm my opinion concerning the value of moist heat in rheumatic conditions. I should like to add, however, that in hydrotherapy, elaboration of apparatus is of secondary importance to the efficiency of the bath-house staff.

Spa Treatment. — In spas mainly concerned with the treatment of rheumatic patients, hyperthermal, that is to say, hot, baths naturally predominate, and there is a tendency for the value of cool and cold baths and douches to be overlooked, or when applied to be regarded mainly as cooling procedures for use after thermal baths rather than as a means of producing healthy reaction. Whereas a properly equipped spa with suitable waters may be the ideal place for the physical treatment of rheumatic cases, it is obvious that all such cases cannot be sent to spas and as already stated, hydrotherapy through the medium of plain water yields excellent results. Three or four weeks' intensive in-patient treatment, which makes it easy for the patient to rest, in bed if necessary, immediately after leaving the bath house, and the avoidance of fatigue and exposure, are usually much more beneficial to the rheumatic patient than a much longer period in which attendances are made, even daily, as an outpatient.

Chronic Rheumatism. — To-day, and particularly in country districts, there are thousands of chronic rheumatics in need of physical treatment for relief of pain and restoration of mobility. Many of them live miles from the nearest general hospital. They cannot afford the train or bus fare for frequent journeys and the physiotherapy departments now in existence are far too busy with traumatic and other acute cases to give them proper attention. Most of the Public Assistance Hospitals have an adequate hot water supply, and a hydrotherapy department could be established in each at very small cost. If facilities for such adequate physical treatment were provided, patients might truthfully be told that they offered a prospect of cure or at least alleviation, and, particularly when they saw that others had derived such benefits, any objection to

going to a Public Assistance Hospital would rapidly disappear.

COMBINED TREATMENT. — Until recent years spa treatment consisted almost entirely of drinking, and of bathing in, the spa waters, with regulation of diet and rest or exercise. The introduction of electrotherapy provided a means of giving intensive "local" treatments which were usually prescribed on the days intervening between immersion or douche massage baths, while the latter exerted their progressive systemic effects. When a new centre is being built up for the administration of physical therapy the equipment should include the apparatus for giving both electrotherapy and hydrotherapy and should be under the control of a physician who understands the rationale of both methods of treatment. It is sometimes overlooked that one may have expert knowledge of electrotherapy without knowing the elementary technique of hydrotherapy and vice versa. The site of the physical treatment centre should be within easy reach of the beds of the general hospital, not only in order that physical therapy may be available for the patients from all parts of the hospital, but in order that there may be cooperation between all members of the staff.

The Rationale of Hydrotherapy

Whereas the use of water goes back to the earliest times in which there is any evidence of the practice of healing, modern hydrotherapy dates from the remarkable results obtained by the empiric methods of Priessnitz only one hundred years ago, when hydropathy became a cult which spread very widely and was applied with more enthusiasm than reason in all forms of disease. Subsequently Winternitz and his contemporaries investigated these methods and supplied an explanation of their mode of action which did not contravene physiological knowledge. It was Winternitz who first indicated that in addition to the local effects of baths the stimulation of the nerve endings in the skin originated impulses in the central nervous system which produced changes in the respiration, circulation and general metabolism. Lewis in *Blood Vessels of the Human Skin and their Responses* (1927), has explained the nature

of the peripheral changes produced by baths, but there is much which is still unexplained about their systemic effects. What determines the type of response, including visceral changes, which results from the spread of activation induced in sensory nerves by physical agencies such as the temperature and pressure of water in contact with the skin is still obscure, though they probably take effect through the paths of the autonomic nervous system. The frigisensitive state is usually an indication of a general lowering of vitality and is accompanied by a poor skin reaction. The drip sheet, the wet pack accompanied by friction or the cold affusion carefully graduated in successive applications, are measures which the hydrotherapist employs not only to restore a normal skin reaction but also for their general tonic effect. How they produce increased vitality and a feeling of well-being is a matter of surmise, but this is not peculiar to the effects of hydrotherapy.

Treatment by Hydrotherapy. — In the treatment of traumatic and rheumatic conditions the use of hyperthermal baths and douches predominates, but in the very much wider field of disease in which hydrotherapy may be employed, cool and cold baths are more frequently indicated. The somewhat Spartan methods of the empiric hydropaths of the last century became unpopular largely owing to the neglect of the rule that cold applications should always be accompanied by friction, that immersion baths should seldom be applied to the whole body below a temperature of 70° F., but also mainly because it was not understood by their imitators that the main object of the application of cold is to produce a healthy reaction rather than to lower body temperature.

The technique of hydrotherapy is clearly and concisely stated by Baruch in the *Epitome of Hydrotherapy* (1920). The publications by more recent authorities on physical medicine such as Kovács and Krusen describe later developments, but Baruch gives the essentials, and the value of hydrotherapy may fairly be judged by the results of the faithful application of his methods; such results in many cases can perhaps best be described by the one word rehabilitation.

MASSAGE, MOVEMENTS AND EXERCISES IN THE TREATMENT OF NERVE SUTURE AND REPAIR

By JAMES MENNELL, M.D.

Massage, since it is instinctive, is the oldest of all remedies, yet of recent years it has tended to lose popularity during a period in which new, and in the main less efficient, remedies have been given trial. Now the pendulum is swinging back again, and since the war-time restriction on short-wave therapy has been in force the tempo of its swing has been increased apace. This is as it should be; we cannot afford to let drop into disuse the oldest and most valuable element in our armamentarium of physical treatment.

General Principles of Massage for Nerve Suture Cases

If it is to be of service in cases of nerve suture, massage must be used in the right way, at the right time and with consummate skill. The work of the members of the Chartered Society of Massage and Medical Gymnastics is very varied, and it is only natural that we should expect to find individual differences in skill and technique. Thus one masseur may excel in the treatment of fractures and yet be well-nigh useless in the treatment of a case of insomnia, and vice versa, although in the main the massage technique is similar in both cases. Again, in cases of nerve suture, some masseurs are unfit temperamentally to do the delicate and concentrated early work, although perhaps most admirably suited for the later treatment when movement has been substituted by exercise, gymnastics and class work. The first duty, therefore, of the medical officer in charge is to aim at a knowledge of the *métier* of each member of his staff and so far as it is possible to see that his chief assistant apportions the work suitably and changes hands when the right moment arrives. A masseur or masseuse should never resent this change, since it is generally made in order to free him or her to do work for which the

colleague to whom the patient is passed is less fitted, and is often a mark of approval. Idiosyncrasies of patients or the development of relations with patients which may affect efficiency — not very common factors it is true — may also demand change of hands.

Pre-Operation Period

CUPPING.—One thing which the surgeon should dread more than another in an operation for nerve suture is sepsis. Usually, and especially in war injury work, these operations are required for conditions supervening on open wounds and the lurking danger is always present even when the outlook is apparently most favourable. In massage we have a most valuable remedy for testing the suitability of a case for operation; there is nothing in the investigation of sepsis which can approach in efficiency the use of a Bier's cupping glass, but again the right technique must be employed. Free use of soft paraffin, preferably the white variety, is an essential; this is rubbed freely but lightly all over the area to be cleared for operation. Then the cup is applied, with light suction in the earlier stages, this gradually increasing in strength until the full suction which the cup will allow is exerted. The treatment is not adequate unless the cup is pulled along all over the area involved. Shaving the part should not be necessary if an ample amount of grease is used, although it is an additional precaution to be recommended for use before the last treatment is given. By this means bacilli lurking without sign in the many possible loopholes in the skin are stirred into activity, and a pustular rash breaks out. If there is not any reactionary rash the skin at least is safe for surgery.

TREATMENT OF DEEPER STRUCTURES. — Much the same may be said of the deeper structures, but the technique is entirely different. This should comprise all the various forms of massage in due rotation, including picking up of the scar tissue and rubbing it between finger and thumb, moving it as freely as possible with stroking movements on either side in turn so as to stretch it to the uttermost, and, perhaps most important of all, fixing the scar with finger and thumb of one hand whilst moving adjacent structures with the other,

preferably by movement of the appropriate joints. If it can be used without causing undue pain, a large mechanical vibrator may be applied freely. If massage fails to stir up sepsis into activity, the chances are that the surgeon will fail to do so too.

MAINTAINING MUSCLE VITALITY.—In the pre-operation and preparatory phase everything should be done by massage and exercises to keep joint and muscle senses intact throughout the part affected, to maintain full mobility or to restore it if lost, to encourage the fullest activity in muscles which are free to contract and to devise movements and exercise — and "exercises" too — in order to maintain the vitality of the part as a whole. This is by far the most important method of maintaining an efficient blood supply to the paralysed muscles during their enforced quiescence.

Post-Operation Period

Motor nerve trunks at the usual sites of suture are placed in the fascial planes between muscles, and since in every wound repair starts on a plan common to all, the site of suture in the nerve trunk must be surrounded by the scar-tissue formation in the structures with which it is in contact. Two evils arise, therefore, unless steps are taken to combat them. First, scar tissue tends to contract and any contraction around the newly growing nerve fibrils cannot serve to encourage their growth. In fact we know that cicatricial contraction around a normal nerve trunk is sometimes enough to produce paralysis, and it is necessary to free the nerve trunk from the scar before it is once more able to convey impulses to the muscles. Any steps which can be taken to combat cicatricial contraction are, therefore, well worth while. Secondly, if the nerve trunk is allowed to become adherent to the muscles, it necessarily follows that when the muscles contract they must exert a pull or tension on the adherent nerve trunk, which again can only have a most inimical effect on the growth of the new fibrils.

EARLY MASSAGE. — The skin surfaces are united reasonably firmly by organizing granulation tissue in a week or ten days, and a similar process goes on simultaneously beneath the skin. Attempts to combat

the two evils mentioned above should therefore be adopted without delay. Any skilled masseur or masseuse should be capable of looking after a wound with stitches still *in situ,* and in massage we have the only prophylactic against the dangers under discussion. As may be expected, the work is delicate, and any abuse tends to encourage rather than to discourage the scar-tissue in its formation. The fact remains nevertheless that massage, which merely faintly mobilizes the tissues, is the only means of prevention of tissue contraction and its associated complications. The best results are obtained when treatment is applied early in the critical ten-day period referred to above; and the ideal time to start is as soon as it is known that sepsis as the result of operation is not likely to occur, i.e., about the second or third day after operation.

Treatment of the Paralysed Muscles. — Controversy has raged over the suitability of massage for flaccid paralysis, and rightly so, since so much more harm than good may be done by abuse of treatment. Factors such as these must not be used to make a case for condemning the legitimate and proper use of massage, particularly as the latter can be very important. The masseur or masseuse whose main delight in treatment is to see "a good healthy red glow" in the skin over the paralysed muscles is to be avoided as unfit for this type of work. Only by the most careful and delicate touch can we hope to render useful service; to compress a flaccid muscle against a bone is an unpardonable sin, second only to that of splint or bandage pressure. The object of applying massage to flaccid muscles is to move the muscle fibres themselves and the fibrous tissue surrounding them, so as to maintain mobility. In ordinary life any form of massage which is calculated to have a baneful effect is counteracted by reflex contraction — a manifestation of the instinct of self-preservation. If, however, the muscles are unable to respond by contraction, reflex or otherwise, it follows that they are impotent to protect themselves and so are vulnerable to every injury. Part of the general value of massage is no doubt to stimulate the activity of the unstriped muscle fibres in the walls of the arterioles. The first effect of massage is to cause a reflex contraction; soon the reflex arc begins

to tire and then a paralytic effect is liable to follow which may defeat the very objective which it was hoped to attain. So far as the rest of the limb is concerned, full brisk massage may, and should, be given with advantage, and one of the ways in which it is possible to judge between good and bad technique is to compare the changes in technique which take place when treating paralysed muscles and when treating muscles which have remained normal.

Treatment During Recovery

Most people are aware of the comfort which can usually be secured as a result of massage after an unusual dose of vigorous exercise. Some who have had a prolonged illness must also know how very small a result follows a long and tiring effort during the early stages of recovery. A muscle which has been cut off from its nerve connexions must sooner or later, if recovery is to take place at all, make its first contraction; so far as this particular muscle is concerned, it may well be that what appears to be only a dim and feeble flicker to the onlooker is to the muscle fibres themselves a violent and severe effort. Hence it follows that, during the early stages of recovery, any successful attempt at contraction may with advantage be followed by massage of the same type as that which should be applied during the stages of complete paralysis. In this way a muscle can be encouraged to make this comparatively vigorous effort a second and perhaps even a third time, but the danger lies in encouraging it too much. It cannot be expected that a maximum effort should be repeated very often unless the individual concerned is in training; a mere flicker of movement is the maximum possible during the earlier stages of recovery. From beginning to end, therefore, massage should find its place in treatment, i.e., up to the point at which active movement can be employed instead, since it may truly be said that active muscular contraction provides the most perfect form of massage for the muscle when it can perform its own massage proficiently. Massage of the right type from an external source, provided it is not abused, is of the utmost service until this point is reached. One more point: it is ridiculous to suppose that a maximum effort can be made

every day, and it may well be that the masseur or the patient may be temperamentally unfitted on a certain day to encourage the effort, or perhaps it may be that too much was attempted the day before. In this event, too, it is always wise to cease to encourage any effort, while massage of the limb will often make the advance on the next day all the greater.

Movements

There is general agreement that the one and all-important point in the treatment of flaccid paralysis is to avoid stretching of the paralysed muscles. The question which arises at once is: "What is the exact meaning of the word 'stretching'?" We now pass into the land of controversy again, but certain points seem to be quite definite. First, we depend for co-ordinated muscle movement on our muscle, tendon and joint senses; anything which is done to interfere with the free functioning of any of these must, therefore, of necessity disturb co-ordinated movement and so render it more difficult for the patient to begin the earlier movements of contraction. One of the things which outrages the joint sense more than another is fixation, and particularly fixation at the limit of the physiological movement. Moreover, absolute fixation of any sort in any limb which is severely injured is liable to lead, to a greater or less extent, to the loss of mobility in the joints. It is clearly impossible for a muscle, which has to make a maximum effort to contract at all, to succeed in moving a joint which is already so stiff that even a normal musculature would fail to move it. Movement must, therefore, be maintained at all costs at every joint in the limb, particularly the movement which is normally controlled by the paralysed muscles. Hence it follows that, if joint movement is essential, a certain amount of muscle movement, with or without muscular contraction, must also take place.

Range of Movement. — We come to the next consideration — the range of movement which it is safe to give without stretching the paralysed muscle fibres; there is no hard and fast rule to guide us as to the range of movement which will produce a weakening effect upon these, but a good working rule is that movement of the

joint through the inner half of the arc of the range of the movement puts no strain whatsoever upon the paralysed muscle fibres. At some early stage, very soon after the outer half of the arc range of the movement is reached, the danger point is to be found, and therefore not in any circumstance should any movement into this outer half be allowed until the muscles by reflex contraction are strong enough to secure themselves from injury. If it so happens that the surgeon has been forced to suture the nerve with the muscles in such a position of flexion that extension through half the full range of movement would lay undue tension on the suture point, the law enunciated becomes void. If, however, the nerve has been sutured with such a degree of tension that extension through 75 per cent of the full range is not possible, the prognosis in any event is bad. Therefore, if we grant that for the purposes of treatment no stretching will take place within the first 50 per cent of the arc of the range of movement, we can be reasonably certain that none will take place if the limb is rested, with the joint, for example, in a position representing about 45 per cent of the full range or within 25 per cent of the range of the inner half of the arc. These figures having been taken as a working basis, the immobilization of the joint at the limit of movement should rarely if ever be necessary; if unnecessary, it should never be practised. When it comes to the question of the extent of movement which may be legitimately performed, we must always bear in mind that in every joint in the body there are two definite sets of movement which are possible. First there are those which are not under voluntary control; secondly there are those which are. The freeing of the movements which are not under voluntary control, the chief of which is tension, involves the complete technique of the mobilization of joints which is not only an art in itself, but is based upon the living anatomy of joints, a thing quite distinct from the anatomy of the cadaver. The movement of joints through the range of voluntary movement have also an anatomical and physiological basis which again needs a special study of living anatomy. As it is impossible here to deal with joint manipulation *in extenso,* only one or two illustrative references may be made. Why is the glenoid fossa

pear-shaped, while the acetabulum is round? The answer to this question is that provision has to be made for the head of the humerus to glide downwards on the surface of the glenoid fossa during the elevation of the elbow into forward flexion or into abduction in order to allow the upper end of the humerus to slip under the acromion without nipping the soft structures between the two bones. So, too, although joints are described as hinge-joints, there is really no such thing in the body as a true hinge-joint. In the instances given above one bone surface glides over the surface of another bone. No one should undertake the treatment of the conditions under consideration without at least a working knowledge of the living anatomy and physiology of joint movement.

Movements of Paralysed Muscles. — Having done everything in our power to maintain joint mobility throughout, in so far as this is possible without putting tension on the paralysed muscles, we then have to consider the movement of the muscles which have been paralysed. Here we must face the fact that individual muscles are not represented on the cortex of the brain, yet it is from this area that the imperious command goes forth that movement must be performed, and this involves not only the movement of the prime-mover but also the active relaxation of the antagonists and contraction of the synergists. We must always remember that muscle has two vital activities, those of contraction and relaxation, and the vital activity of relaxation is certainly no less important than that of active contraction. Once the stimulus has arisen in the cortex the responsive movement must be effected to some degree and if some of the motor fibers fail to carry through the impulse, or if the affected muscles have not sufficient strength to move the load, the cerebral command is so insistent that something must be done. The weak muscle shuns the attempts but others combine to effect movement, and so there is often seen an extraordinary conglomeration of activities which can best be described as "confusional insanity" of muscle movement. Reduction of the load reduces the confusion. Transference of some of the load will often encourage contraction in the weak muscle which otherwise is impossible. The reduction of the load invariably

involves the use of gravity, but it must always be remembered that the latter is a force which can just as easily be abused as any other method of treatment.

MUSCLE RE-EDUCATION. — Space prevents a full discussion of postural treatment, but below are given the main laws.

1. Teach the antagonist to relax.
2. Demonstrate on the sound limb not only how relaxation of the antagonist is an essential part of contraction of the prime-mover, but also the movement for which the prime-mover is individually responsible.
3. The adjustment of the load through the use of gravity should be so gradual that the addition of the load should be imperceptible to the muscle although perceptible to the senses of masseur and patient alike.
4. At every joint there is some one movement over which one particular muscle presides; it is this one movement which must be sought out for practice in the initial stages.
5. The blending of rest and activity is an art in itself.
6. Both masseur and patient can go "stale." When this happens a change of hands, or better still a complete holiday from treatment, is often of the utmost help.
7. A muscle will first begin to contract when the limb is placed at a position of perfect comfort as near to the limit of the inner arc of the range of movement as can be secured.
8. Fatigue is probably the worst enemy of any paralysed muscle and to try to encourage a muscle to contract a second time because it has already done so once is often a satisfactory way of postponing recovery.
9. It is absolutely necessary to keep in the fullest possible activity all muscles which are not affected and if possible in unison with the muscles of the unaffected side.

Finally, two controversial subjects may be dealt with — the posture of the part between treatment, and the action of the antagonists when recovery is beginning to take place. It is almost impossible for a weak muscle to contract unless some movement is possible as the result of its effort. This probably has something to do with the action and interaction of muscle movement and the muscle, tendon and joint senses. In other words, to fix the part affected to a splint in such a manner that movement cannot take place in response to voluntary effort is simply to create incapacity and definite postponement of recovery. There is a hankering delusion in many minds that if the antagonist of the movement is allowed to contract it will so

develop its strength that the prime-mover will never have a chance to pull against it. This would be perfectly true if in physiological movement the prime-mover had to pull against its antagonist; this ignores the point already made that active relaxation is as large a part of physiological movement as is active contraction. It is utterly wrong to suppose that an antagonist by sheer development of bulk will overcome the action of the prime-mover, because the function of the antagonist is to relax when the prime-mover contracts. Hence it follows that everything possible should be done to maintain intact the power of an antagonist to relax and to impart the knowledge of how to do it. This again can be accomplished only by freedom of movement in no matter how small a range.

Criteria of Muscle Recovery. — A few more points only can be given emphasis in this all too compressed summary. During the early stages of the epidemic of nerve suturing during the war of 1914-18 rumour spread that no active contraction was possible until a faradic response had been obtained. This belief persisted for some time until the mass of cases which exposed such false conception was so great that it was finally, albeit with reluctance, allowed to die the death it so richly deserved. No doubt the rumour originated in the minds of those who were so ignorant of the elements of muscle training and re-education that, for them, it was true. But those who knew better were always aware that even active movement may be possible months before any faradic response is obtainable. When we add to this the fact that it is highly probable that active contraction of itself hastens the date of the return of faradic response more rapidly than anything else, it is at once obvious that an enormous waste of time from the point of view of recovery must be associated with this most pernicious doctrine. The second point, closely allied to the first, was the teaching that it is wrong to try to encourage a muscle to contract until it has been established, usually by faradism, that it is able to do so. This may well mean waiting for a day which never comes. Two things are certain: first, a patient can actually forget how to move, and secondly, movement will come voluntarily only as the result of voluntary effort. If this effort is not made before

voluntary response is possible, it is inevitable that the earliest possible moment at which it can be elicited will be missed. To say that disappointment will follow repeated failure is nonsense, if the *raison d'être* of the treatment is fully explained. Moreover, by the skilled use of gravity, the movement can be made to take place in response to the effort by means of assisted movement, and this is an essential part of training the antagonists to relax. A third point is that the only thing above all others to discourage in the mind of the patient is the idea that because some muscles are paralysed the limb is therefore useless. Thus a patient with a musculo-spiral (radial) paralysis can do a heavy day's work on a weight and pulley apparatus provided only that the forearm is kept in pronation. This leads directly to the fourth and fifth points, namely, that double arm or leg work will always hasten recovery more quickly than single; and that static contraction of a muscle will often yield a response before the muscle is willing to contract as a prime-mover.

Climate and Muscle Training

It has been said that in Great Britain for instance muscle training is well-nigh a hopeless task from November to April inclusive. This should not be so. A heavy spell of exercise of the whole body will warm up the damaged limb, even when it is only the limb of the opposite side which is exercised. Nevertheless the part involved should be warmed through and through for not less than half an hour in a hot bath or before a hot fire immediately before treatment. To try to elicit an early response in a chilled limb is useless, yet how often is it done.

Exercises

A mere summary of the essentials in exercise is apt to detract from the value of the exercise treatment rather than to enhance it. This much, however, may be said: the aim of treatment is restoration of function and this restoration depends on function. In other words, until recovery is complete anything and everything which can be devised to exercise the recovering muscles should be prescribed.

The transition from the first doubtful quiver to full and perfect contraction should be continuous, but in the final stages exercise treatment should include appropriate work in the gymnasium, the playing field, the garden and the swimming bath.

One of the main points to keep in mind is the deleterious effect of gravity when it opposes the action of a weakened muscle. Anything we can do, therefore, to ease or eliminate the action of gravity is of service. Hence it comes about that when recovery has advanced to a point at which the muscle can contract by itself without undue fatigue, exercise with the part immersed in water is always more profitable than exercise out of water. The brine bath at Droitwich, by eliminating the action of gravity altogether, is perhaps the best place for people whose recovery is being established. Sea-water swimming baths, preferably warmed, come second; while an ordinary bathe in sea-water (provided the limb is not chilled by it) should invariably be prescribed whenever it is possible and particularly for paralysis in the lower extremities. Gravity can also be eliminated by the use of sling apparatus, and that devised by Mrs. Guthrie Smith is the most suitable. In winter particularly it is a good and efficient substitute for under-water work. The weight and pulley used intelligently can work wonders, and particularly in training muscles by static contraction.

For the upper extremities there is no question that double-handed work is infinitely more valuable than single handed; e.g., clipping a hedge with a pair of shears. Finally we must keep in mind that the muscle will often act more readily with work as a synergist either active or static than it will as a prime-mover.

"Wilt thou be made whole?"

If the answer is in the negative, i.e., if the patient cannot will to regain function, we are up against a hopeless proposition, but during the war of 1914-18 there were exceptional cases of patients in whom the musculo-spiral (radial) nerve was sutured in the upper arm and who went back to their ordinary military duty within six months. But when treatment throughout is intelligent, and adjusted to the

requirements from day to day, and when above all the will to get well is sufficiently strong to inspire the utmost endeavour, recovery at this pace should be the rule rather than the exception. Notoriously some nerves recover control over the muscles more rapidly and more completely than others, but speed in recovery depends very largely upon one thing: whether the patient can and will do his utmost to hasten it instead of waiting for someone else to recover function for him, which is impossible. Recovery certainly is made possible for the patient by the surgeon; but all that can be done is to point the road to recovery day by day and to emphasize and avoid those things which will retard it. Without the full co-operation of the patient we are powerless.

It has been said that it is far easier to rub a disability into a patient's mind than to rub it out of his limb; this applies to all forms of physical treatment other than voluntary work, and more particularly to the faradic current, the main function of which is re-education of muscle and tendon sense and the teaching of individual muscles in contraction.

USES AND ABUSES OF SPLINTS AND OTHER INSTRUMENTS IN THE TREATMENT OF NERVE LESIONS

By T. P. McMURRAY, M. Ch., F.R.C.S.E.

When a purely motor or mixed motor and sensory nerve has been divided and its conductivity lost, the muscles supplied by it lose their tone and allow the joint on which they normally act to assume an abnormal position, owing to the unbalanced action of the opponent muscles. The deformity is, as a rule, not due solely to the loss of tone in the paralysed muscles, but rather to a combination of this with the force of gravity.

Splintage for Paralysis

A very good illustration of the combined action mentioned above is seen in injury to the radial nerve with its very characteristic sign of dropped wrist. If, directly after injury to the nerve, the forearm and hand were held continuously in full supination with the elbow at right angles, gravity would act as a dorsiflexor, and its force would be sufficient to counteract the pull of the unbalanced flexor muscles of the forearm. In this position of dorsiflexion the paralysed extensor muscles would be relaxed, which is the ideal condition for a resumption of function if and when the conductivity of the nerve has been restored. When the paralysed muscles are allowed to remain overstretched their power of contractility is lost, even after restoration of function in the motor nerve supplying them, and this power of voluntary contraction can then be restored only by maintenance of the affected muscles in the relaxed position over a long period of treatment. These instances of the vital importance of position and relaxation of paralysed muscles during the period of their loss of power of voluntary contraction constitute the basic principles which underlie the treatment of paralysis by splintage. Muscles

which have temporarily lost their normal nerve stimuli through a lesion of their motor nerve are restored to full activity rapidly, provided their fibres, during the period of loss of function, have been protected from the injurious effects of overstretching.

Danger of Rigid Deformity

When a group of muscles is paralysed by injury to its motor nerve deformity results in the joint on which it acts, and if such deformity remains uncorrected secondary contraction occurs in the opposing group of muscles, thereby preventing even passive restoration of the normal position. A very good illustration of this is seen in the state which arises in paralysis of the extensor muscles of the leg caused by a lesion of the external popliteal nerve. In these circumstances, if the foot remains in the drop-foot position the paralysed extensor muscles are overstretched, and a secondary accommodative contraction of the calf muscles and posterior capsule of the ankle joint converts a passive into a rigid deformity. Deformities of a similar type are seen after lesions of any of the large motor nerves, although in most instances gravity has not such a direct influence on their production. Thus, with division of the ulnar nerve the unopposed action of the long extensor and flexor muscles of the fingers rapidly produces the deformity of *claw hand* owing to the loss of action of the small interossei and lumbrical muscles.

Essentials of Satisfactory Splintage

When recovery of the injured nerve is a possibility it is essential that the muscles supplied by it should be maintained in a position of relaxation until they once more take up their normal function. If, for instance, the external popliteal nerve has been sutured after division, recovery of function in the paralysed extensor muscles would at best be very considerably delayed if the foot were allowed to remain plantar-flexed. The recovering muscles would then have to attempt the impossible task of dorsiflexing the foot against the contracted calf muscles and the shortened capsule of the ankle. This difficulty can be avoided by using some form of apparatus during

the period of paralysis of the extensor muscles, in order to maintain the position of muscular relaxation and balance. The vital importance of splintage in the treatment of paralysis is most readily appreciated in acute anterior poliomyelitis, in which early splintage and physiotherapy are of such great importance. When a child is affected by infantile paralysis the loss of power is at first much more extensive than the permanent disability. In the acute stage of the disease the anterior cornual cells are affected over a very wide field, but the area of permanent cell destruction is usually only a small portion of the primary involvement. Intelligent splinting of the paralysed muscles in the acute stage prevents the development of deformities, and assists in the recovery of power in large groups of temporary functionless muscles, a recovery which does not take place in those muscles which have been overstretched. The sole object in splinting a paralysed muscle is thus to prevent the overstretching of muscle fibres, and to enable voluntary power to be restored rapidly after the recovery of conductivity in the injured nerve.

Degree of Relaxation

In using splints for the treatment of paralysed muscles it is naturally essential to determine the optimum amount of relaxation to be aimed at. Should the joint on which the paralysed muscle acts be maintained at a neutral or at an over-relaxed position, and would the rate of recovery of function be hastened if an extreme degree of relaxation were provided? This question can again be understood most readily in relation to paralysis of the radial nerve. Would the rate of recovery of the temporarily paralysed extensor muscles be improved by holding the hand and fingers in the most extreme degree of dorsiflexion rather than in the neutral position in which all the muscles of the forearm are equally relaxed? Clinical evidence supports the theory that the optimum angle for recovery of the muscles is the neutral position at which a return of voluntary power appears at the earliest possible moment. When the hand and fingers are maintained at the extreme range of dorsiflexion the

extensor muscles are so fully relaxed that the appreciation of the recovery of voluntary power is much delayed. This may be readily understood, since the stimulus necessary to produce active movement in a muscle in such extreme degree of dorsiflexion is greater than when the wrist and fingers lie in the horizontal plane. Even with normal muscles the effort necessary to pull the wrist into extreme dorsiflexion is very much greater than that required for movement through the first few degrees from the horizontal plane. The ideal position of rest for the wrist and hand in treating paralysis of the extensor muscles is an angle of 10 to 15° dorsiflexion of the wrist with each of the interphalangeal and metacarpophalangeal joints flexed to an angle of 10°, the thumb being held abducted from, and anterior to the plane of the palm. (Figs. 1 and 2.) In this position

Fig. 1. Suitable type of metal splint.

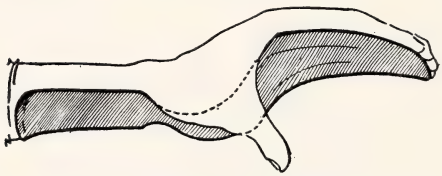

Fig. 2. Correct splinting, using the type of splint illustrated in Fig. 1.

not only are all the muscles of the hand and forearm relaxed, but the ligaments of the wrist and finger joints are not under strain, retaining their mobility even after prolonged fixation. In applying the splintage, whether this be in the form of metal, moulded plaster slab, or leather wristlet, the normal curves of the hand must be preserved.

Unsuitable Splints

During the early stages of the war of 1914-18 the use of unsuitable and badly-designed hand splints produced unnecessary disability and rigidity of the hand and fingers. The original splints commonly used for paralysis of the extensor group of muscles consisted of two flat metal plates joined together at an angle of 45°.

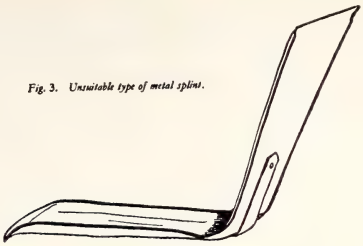

Fig. 3. Unsuitable type of metal splint.

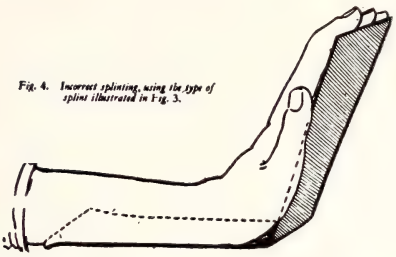

Fig. 4. Incorrect splinting, using the type of splint illustrated in Fig. 3.

(Figs. 3 and 4.) They were applied to the palm and the flexor aspect of the forearm, and were often left in position without removal and without any physiotherapeutic treatment for several months. Their primary object of muscle relaxation was achieved but, owing to the fully extended and often hyperextended position in which each of the joints of the fingers was fixed, persistent and often permanent rigidity of the fingers was inevitable. Such unnecessary complications can easily be avoided if it be remembered that the palm is normally concave, and that only if this curve is maintained can the fingers work at their full mechanical advantage.

Position of Rest

The question has often been asked: Does not prolonged fixation of a joint by itself produce rigidity? It may be taken as a basic principle of treatment that a normal joint with normal periarticular tissues can be immobilized in a position of rest almost indefinitely without producing either permanent or troublesome rigidity at the joint. By a position of rest is meant one somewhere in the angle between the positions of extreme flexion and extreme extension; if, however, either of these positions is adopted, even for a comparatively short time, rigidity follows owing to a stretching of ligaments

and the formation of adhesions round the site of strain. The condition of the periarticular tissues is of the very greatest importance in the production of rigidity; when these periarticular tissues are swollen by inflammation, or œdema from a neighbouring wound, fibrosis and shortening of the ligaments can be expected but in the absence of such inflammatory swelling rigidity does not occur as a result of temporary absence of movement.

Principles of Splinting

The principles of splinting to be used in the treatment of paralysis of any muscle, or group of muscles, can be summed up by saying that the essential object is the continuous relaxation of the paralysed muscle tissue for a period sufficiently long to aid the restoration of function, assuming always that recovery takes place in the nerve supplying the paralysed muscle. In carrying out the treatment the utmost care must be exercised to preserve the normal position of rest of each joint of the affected limb, and to prevent the crippling rigidity which is the inevitable result of fixation in deformity. The particular type of splint or case used for the purpose naturally varies according to the mechanical ingenuity of the medical attendant; any apparatus is satisfactory so long as the principles stated above are remembered, and so long as the application of the splint does not involve any interference with the normal blood flow through the paralysed muscles, for it is of little advantage to retain the paralysed muscles in the relaxed position if, at the same time, the normal flow of blood through their substance is prevented by bandaging. This error in treatment is most commonly seen in the application of the hand splint for paralysed extensor muscles. The usual type of splint requires bandaging of the hand and forearm to the splint, thereby losing the full advantage of rest and relaxation. The bandage necessary for fixation should extend only for a distance of 3 inches above the wrist joint and in the area occupied by tendons and not by muscle bellies. In this way circulation through the affected muscles is unrestricted and the muscles remain in a condition predisposing to recovery of function.

Duration of Treatment

Recovery after nerve injury may be long delayed; the first signs of restoration of function may appear in a few days or only after twelve to eighteen months, but if the full advantage of splintage is to be obtained the period of its employment must be sufficiently prolonged to gain its objective. It is difficult to put a time limit on the usefulness of splintage; the judgment as to its value must be based on the changes in the electrical reactions of the paralysed muscles. If these are improving and are approaching normality, rest and splintage of the muscles should be continued until voluntary power is restored, but if the reactions indicate that the muscle tissue is degenerating in spite of adequate treatment, further employment of the support can of itself be of little advantage.

Conditions Suitable for Splintage

Splintage is of value in almost all motor nerve injuries, but it has its greatest usefulness in those nerve lesions which cause paralysis of extensor groups of muscles, i.e., in the groups which normally act against gravity. Classification according to extensor groups includes paralysis of the muscles supplied by the radial nerve and the external popliteal nerve, and also paralysis of the shoulder girdle muscles, in which the power of abduction of the arm is lost. In each of these groups the action of gravity increases the deformity, and in each, too, relaxation of the paralysed muscles is an essential factor in treatment. So far as paralysis of the muscles supplied by the ulnar or median nerves is concerned splintage is not so valuable, in fact in paralysis of the ulnar group of muscles splintage of any kind is a distinct disadvantage, as it is so frequently followed by persistent rigidity.

Conclusion

In conclusion, it may be said that splintage of a paralysed muscle or of a group of muscles is used solely to prevent the overstretching of the inactive muscle fibres during the period of the loss of nerve stimulus. By splintage the paralysed muscle fibres are relaxed and

kept in the most advantageous condition for a restoration of function if, and when, the function in the motor nerve is restored. Splintage improperly used may be the cause of crippling rigidity owing to the fixation of a joint at an angle other than that of rest. Some form of support from splintage may be required for many months, and should be persevered with so long as the electrical reactions indicate an improving nerve function.

GRADUATED EXERCISE IN TUBERCULOSIS

By ALBERT MARTIN, M.D.
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Some tuberculous patients have average recuperative powers, some have more than average, and others, unfortunately, have little resistance to the disease process. With recognition of the variations in the physical, mental and spiritual endowment of his tuberculous patients, the clinician is to select those who are to be put on graduated exercise.

Since Trudeau founded the first American sanitarium for the tuberculous, at Saranac Lake, N. Y., in 1884, controversy has continued with regard to the proper application of this therapeutic measure, and differences of opinion still exist in this matter. One, the conservative school of thought, thinks that the use of graduated exercise is justified only when the lesions are completed fibrosed, as shown by X-ray study. Another school favors graduated exercise for well selected patients who may still have some limited infiltration, but are comparatively free from serious constitutional symptoms.

In considering the placing of tuberculous patients upon graduated exercise, the following questions will come up:

1. Should the presence of moist râles, with or without positive X-ray findings, but with sputa negative for tubercle bacilli for three or more months, and with comparative freedom from constitutional symptoms, contraindicate graduated exercise?
2. All other factors being favorable, should an occasional temperature of 99° to 99.5° act as a bar to graduated exercise?
3. Should a pulse persistently above 90° contraindicate graduated exercise?
4. Should an occasional positive sputum, say once to three or four times a year, contraindicate graduated exercise?
5. Should a large amount of purulent, blood-streaked or bloody sputum, contraindicate graduated exercise, when all other factors are favorable?

6. Is graduated exercise advisable after successful induction of artificial pneumothorax or other form of collapse therapy?

Discussing these briefly, in sequence, it may be said that many clinicians see no interdiction of the employment of graduated exercise in circumstances cited in 1. Should an unfavorable reaction follow, complete bedrest of the patient is immediately in order. Some students of graduated exercise hold that this treatment "should be begun immediately, in a small measure, at the subsidence of the most seriously regarded constitutional symptoms" (such as fever above 99°, pulse over 90, loss of weight from average normal weight, anorexia, and the mental and physical lethargy that prevails more or less during the tempestuous course of the disease). However, due consideration is to be given to the size of the actual cavity formation before beginning the exercise.

As to question 2, it is the opinion of many competent clinicians that an occasional temperature rise, to 99° or 99.5°, is not a contraindication to graduated exercise, if there be no other serious constitutional symptoms in evidence. Accepted opinion among physiologists is that certain variations from the normal standard in the cells controlling the thermic center in the medulla may be exhibited by some persons.

Relative to question 3, it may be said that, since heart diseases are a frequent cause of death, a pulse which is persistently above 90 calls for thorough inquiry into all the factors that might cause that acceleration; and no graduated exercise to be begun in such cases until proper diagnosis and treatment have restored a normal pulse rate. A complete cardiovascular study, including an electrocardiogram, a basal metabolism test, estimate of vital capacity, study of the blood picture and renal function, with treatment of such foci of infection as are found, are indications in prosecuting this inquiry.

In respect to question 4, a number of clinicians believe that an occasional positive sputum should not contraindicate some form of mild exercise, as long as the patient's resistance is good and no untoward reactions occur during observation under prescribed exer-

cise. A thorough clinical inventory of the patient should be made in such cases, with particular stress on the size and development of any possible cavity formations in one or both lungs. Increase in size of cavities, verified by X-ray examination, would contraindicate any form of graduated exercise.

Regarding question 5, it is to be said a large amount of purulent blood-streaked or bloody sputum deserves careful study to determine the causative factors with relation to tuberculosis. There are a number of conditions that affect the amount and character of the sputum, with or without the presence of a tuberculosis lesion. So-called "post-nasal drip" may be present in considerable quantity, purulent or nonpurulent and with or without blood streaks, when tuberculosis may not be a factor, as in the asthmatic patient, the hay-fever victim and other allergic individuals. Bronchiectasis, tuberculous or nontuberculous, may have an important influence on the amount and character of the sputum. Any form of bronchial irritation or inflammation, or both, are actors that may affect the sputum in different ways. At times, bloodstreaks or even blood in a measurable quantity is evidenced in the sputum, not necessarily due to tuberculosis, even in combined lesions with tuberculosis. In general, the prescription of graduated exercise in these and in many other cases as well should depend upon the general physical and clinical condition of the patient. A thorough study of the sputum, amount, character, culture, guinea pig innoculation, stomach wash, if indicated, etc., should be carried out. If no serious constitutional symptoms are in evidence, and the individual is otherwise qualified, a systematic course of medically regulated exercise oftentime proves beneficial. The patient's temperature, pulse, weight, and blood picture, and his mental attitude (e.g., his desire to get well and, to become useful to society and himself), are the essentially important factors to consider before any course of graduated exercise is inaugurated.

Finally, as to question 6, the advent of artificial pneumothorax, and later, other recognized forms of surgical lung-collapse therapy, together with our present-day uses of vitamin and endocrine therapy

wherever indicated in the treatment of the tuberculous, have all assisted considerably in the arrestment of tuberculosis and in clearing the path for the addition of graduated exercise in selected cases. With the addition, wherever indicated, of physiotherapy and occupational therapy, and careful observation of clinical progress under a medically supervised course of graduated exercise, the patient who has successfully undergone some form of lung collapse, should, if properly selected, continue to improve in health under a course of graduated exercise. The administration of graduated exercise in successfully compressed pneumothorax cases that are comparatively free from any serious constitutional symptoms, is considered advisable by the majority of clinicians who have had extensive experience with this treatment measure.

Roentgenologists of well-seasoned experience in the interpretation of films of the lungs acknowledge that the X-ray picture per se should not necessarily serve in all cases as the sole determinant of the question of administering medically supervised graduated exercise, or the induction of some form or other of surgical lung-collapse.

Experience of past years has proved the consistency of this viewpoint. Institutional records will show many improved or fully recovered patients who had received supervised graduated exercise, with lung lesions showing fibrotic areas, combined with circumscribed or even scattered areas of apparent or suggestive infiltration, with or without circular shadows or apparent small, single or small multiple areas suggesting cavitation. Extended courses of graduated exercise showed resulting X-ray and clinical improvement, when these patients were checked at the three-month intervals.

In like manner, in the consideration of the original X-ray films as a criterion in the matter of proposed induction of artificial pneumothorax, past medical records in many institutions will show many improvements or full recoveries following the successful induction of pneumothorax, in cases where the original X-ray plates had shown evidence of multiple or massive adhesions, or other findings that promised little if any success from artificial pneumothorax or

other forms of surgical collapse. The author can recall a significant number of cases of successfully induced pneumothorax in which the films taken and studied prior to lung-compression showed findings that were interpreted to mean that a satisfactory manometric reading by needle puncture at any site through the pleural tissue was impossible. It has been a further experience that in some cases with unfavorable X-ray and fluoroscopic findings, and when an attempted pneumothorax had proved unsuccessful, a phrenic-crushing on the same side brought about sufficient elevation of the diaphragm to be of distinct therapeutic value.

In view of such frequent fairly pleasant surprises, the clinician is apt to have doubts when, influenced by unpromising X-ray pictures or fluoroscopy, he has refrained from inducing artificial pneumothorax before adopting other therapeutic measures. Recent innovations in X-ray equipment, such as the tomograph, planograph, laminograph, etc., which bring out more clearly the pathological areas in the lung, and circumscribe those areas for clearer vision and study, are of great assistance in prospective thoracic surgery.

Sanatorium physicians of wide experience appear to favor the liberal use of graduated exercise for selected patients having average normal pulse, temperature and weight graphs, regardless whether the X-ray films in these cases show traces of active infiltration. The criterion, in short, is the comparative freedom of the patient from serious constitutional symptoms. This viewpoint may largely be engendered by economic considerations; i.e., by the desire to return these patients to their former positions of employment in their home communities, or to other positions less apt to cause reactivation. Quite often, such sanatoria patients are being treated at the expense of a firm or corporation, whose officers wish the return to work of the employe as soon as possible. And those patients who have a proper sense of responsibility and have families dependent upon them, are equally desirous of being dehospitalized as promptly as may be. This economic consideration is, however, not allowed to vitiate the medical considerations in these cases; and the experience of these sanatoria shows that carefully supervised

courses of graduated exercise among selected cases can early be begun with benefit to the tuberculous lesions.

The use of tobacco by tuberculous patients deserves more thought than is given it. Although it is possible to curtail or regulate to a certain extent the use of alcoholic beverages and narcotics by these patients, it is somewhat more difficult to prohibit or control their use of tobacco. It is not impossible, however, for the ward physician to convince a certain number of his patients that tobacco has a deleterious effect upon active pulmonary tuberculosis. The fact that the use of tobacco is forbidden in the majority of well-regulated private, State, county, and city tuberculosis sanatoria reflects accepted opinion that it retards and seriously interferes with recovery from tuberculosis. Its protracted use causes irritation, followed by inflammation of the delicate membranes of the nose and throat and the gastrointestinal tract. Appetite and nutrition are seriously affected in many patients, according to the degree of indulgence in the weed. Nicotine increases the blood pressure sufficiently in some cases to provoke hemorrhage. Chemically-treated cigarette papers irritate the delicate larynx and produce many so-called "cigarette coughs." Severe coughs paroxysms lower resistance and impair laryngeal function, or cause partial or complete loss of voice, in a certain number of cases. The unfavorable progress toward recovery after complete loss of voice and inability to swallow food is nothing short of tragedy. Explanations of this sort by ward physicians to the more intelligent, self-disciplined, and cooperative of their patients will lead to increase in the percentage of arrested cases.

It is not uncommon while making ward rounds or during locker inspection that a ward surgeon will observe a box of Copenhagen snuff, for a goodly percentage of tuberculous patients have acquired and still indulge in this ancient habit. Since snuff is a tobacco product, its effects are much the same as those of tobacco and equally reprehensible. In fact, it is sound opinion that the elimination of all forms of irritants or stimulants, such as tobacco in any form, alcohol, pepper, mustard, ginger, horseradish, vinegar, Worcester-

shire or other peppy sauces, etc., is indicated, if the best results in the treatment of pulmonary tuberculosis are to be expected.

Vitamin and endocrine therapy in conformity with a select daily diet constitutes an important factor in the rationale of treatment. Graduated exercise may be considered as the treatment finale, administered to bring body resistance to its maximum.

Conclusion

The main argument in favor of the early administration of graduated exercise in selected tuberculosis cases is the comparatively large number of living examples who are leading useful and successful lives.

The liberation of tuberculo-toxins during the period of prescribed graduated exercise appears, in many cases, to have a beneficial effect.

Expectancy of return to a remunerative economic status, to a life of real usefulness, has a salutary effect upon the mind, body, and soul of a patient.

The chest X-ray film and fluoroscopic examination, while to be given ample and just consideration, should not in all cases be the sole or chief criterion in determining whether some form of surgical collapse or a course of prescribed graduated exercise is to be undertaken.

The opinion of the clinician who has daily observed the patient over extended periods, has made the usual periodic check-up physical examinations, and has studied all the important daily graphs of the case, is entitled to as much weight as the opinions of the thoracic surgeon and the roentgenologist in the final decision as to inducing surgical collapse or beginning graduated exercise.

MEDICAL AND HOSPITAL SERVICE EXPERIENCE WITH DISABLED VETERANS OF WORLD WAR II

By CHARLES M. GRIFFITH, M.D.
Medical Director, Veterans Administration

In accepting its responsibility to provide prompt, high standard treatment and care for the new group of beneficiaries that will be created by the current conflict with the Axis forces the Veterans' Administration expects to face its full share of problems. But those problems are at least being anticipated; we think that we can envision their nature, even if their proportions are presently conjectural; and we are planning to meet them. What is still more comforting is that we are today far better prepared for eventualities than we were at the close of the 1917-1918 war. That you may realize this difference in the general situation, I will provide a brief retrospect.

Authorization for the medical treatment of men disabled in the 1917-1918 war was incorporated in the Act of October 6, 1917, amending the War Risk Insurance Act. That authorization was historical; it was the first of its kind in our national history. Prior to its enactment, veterans of our wars were provided hospitalization and other medical treatment only as an incidental to their domiciliation in the then National Home for Disabled Volunteer Soldiers. However, that Act designated no Federal agency to administer that novel benefit, and it was assumed that the Congress intended that the Army and Navy should retain the disabled men of their respective Services until their physical rehabilitation was completed, whereupon discharge to civil life would ensue. The tentative plans of the Army and Navy to this end were disrupted, however, by the insistent demands of the officers and enlisted men, and of their families and the general public that demobilization proceed forthwith.

But immediately upon the return of these discharged men to their homes, there began a deluge of claims for disability compensation and for medical treatment. There was machinery — the Bureau of War Risk Insurance — for the handling of monetary awards; but there was no constituted agency to administer medical benefits. In this emergency, the United States Public Health Service stepped forward and accepted the grave responsibility. From the Army and Navy were taken over all the cantonment hospitals and equipment that could be released and, during 1919 and 1920, some 9,000 hospital beds were made available in this way. The hospitals which were a part of the several then existent National Homes were utilized. Thousands of contracts were made for use of beds in State and private hospitals, and a number of sanatoria were acquired by lease or purchase. Such were the expedients to which the country had then to resort. The difficulties of coping with the flood of claims for various types of benefits was increased by the fact that three different agencies were engaged in administering such benefits. The Bureau of War Risk Insurance handled claims for disability compensation and Government insurance; the Federal Board for Vocational Education attended to vocational rehabilitation; and the United States Public Health Service, as stated, provided medical treatment. It was not until August 1921 that those several functions were transferred to a consolidated agency — the Veterans' Bureau; and it was still years later, in 1930, that the Veterans' Bureau, the Bureau of Pensions and the National Home for Disabled Volunteer Soldiers were further consolidated into the present Veterans' Administration, thereby finally effectuating the obviously desirable unitary administration of all types of benefits for ex-members of the armed forces.

Turning now to the picture of today, we find that the Veterans' Administration has a large, trained personnel in its central office and in offices over the country which, clothed with adequate decentralized authority, can, without delay or confusion, dispose of any class of claims for monetary benefits. And, as to medical benefits, we have in operation 92 facilities offering 62,510 beds for

hospital patients and 18,434 beds for beneficiaries receiving domiciliary care, with incidental medical treatment.

In early 1919 we were starting at scratch to improvise as rapidly as we could some sort of accommodations for ill and injured ex-members of the armed forces. Today we have a nucleus of installations — buildings of a fireproof, permanent type, architecturally attractive, and widely distributed over the States. And we have modern equipment in those stations, and personnel trained to provide any type of medical or surgical treatment.

Our principal problem then, as we see it, will be such expansion of that present nucleus of organization as will fully take care of the needs of the peakload of casualties that will come to us from this present conflict. What must be the proportions of that expansion is, as I have stated, conjectural at present. The casualty load that may eventuate will be determined by a number of factors, direct and indirect. Among the direct may be enumerated the total numerical strength the armed forces will reach; the duration of hostilities; the theatres of operations (that is, tropical, temperate or frigid zones, and the distances of these from the continental United States); and the character of the major operations (that is, whether aerial, naval or land). Among indirect factors will be the relative effectiveness of the physical examinations of registrants and volunteers in the screening-out of poor recruitment risks; the question whether physical standards will be lowered; and whether the Congress may enact statutory provisions, such as presumption of soundness at time of enlistment, and presumption of service origin for disabilities arising at relatively long intervals after separation from the forces. It will be evident that most of the factors I have suggested are not presently ponderable.

Our experience to date in taking over disabled eligible beneficiaries from the new Army and Navy will not help much in estimating the total bed capacity we may ultimately require. The Veterans' Administration, under existing Regulations, is accepting for hospital treatment those applicants who have been discharged from the armed forces for disability in line of duty in active service,

or who are in receipt of a pension for service-connected disability. Up to September 1, 1942, there were admitted to hospitals of the Veterans' Administration a total of 4,377 applicants meeting those eligibility requirements. Of that total, 1,886 patients were suffering from general medical or surgical illnesses and injuries; 1,463 were tuberculous; and 1,028 had neuropsychiatric disorders. For statistical purposes we identify such beneficiaries in two categories: (1) "National Emergency," or those who served on or after August 27, 1940 and were discharged prior to December 7, 1941; and (2) "World War II," or those who were enlisted on and after December 7, 1941. But regardless of this statistical differentiation, the point of material consideration is that these beneficiaries were, in the great preponderance, simply men who broke down in their training. We have not as yet perceptibly felt the incoming wave of combat casualties and, until we begin to feel and to measure it, we cannot project our future probabilities of patient-load. I might further state that we interrogated the War Department as to the approximate number of beneficiaries the Army might release to the Veterans' Administration over the fiscal years 1943 and 1944, but I do not feel at liberty to divulge the information we received in reply. I can only say that the War Department's estimates confirmed the opinion that our experience to date could not safely guide as to the probable future total patient load, nor as to the relative percentages of clinical types in that total load.

In 1937 the President approved a program of additional construction, recommended by the Federal Board of Hospitalization, which proposed the attainment, over a period of 10 years, of a goal of 100,000 beds. But that project was planned, as you will appreciate, to meet estimated peak requirements of hospital treatment and domiciliary care for what were then the only prospective applicants, namely, persons who were potentially entitled because of military or naval service in former wars, or because of discharge for disability in line of duty from peacetime service in the Regular Establishment. The great expansion of the armed forces which began in 1940 with the calling into Federal service of the National

Guard, and the enrollment of volunteers and of registrants under the Selective Training and Service Act was not considered, of course, in that program. That enlargement of the Army and Navy has progressed, if press reports are to be credited, to a total already exceeding the entire enrollment in 1917-1918; and we have the official statement of the Secretary of War that a strength of 7,500,000 men is the present objective. Obviously, the program of additional construction proposed back in 1937 will have to be radically recast to comprehend these greatly changed circumstances; and I can inform you that intensive study has been and will continue to be given to this problem of a sufficient future bed supply.

All planning to meet an estimated peak of requests for hospital treatment and domiciliary care must take into account the fact that the law authorizes those benefits, not only for applicants suffering from service-connected conditions, but also for applicants whose diseases or injuries are not attributable to prior military or naval service. This generous authorization of hospitalization or domiciliation for disabilities not incurred nor aggravated by military or naval service is open not only to veterans of a war, but to applicants whose service had been in peace time only. But with regard to this peace time service group, there is an initial eligibility requirement that does not attach to veterans of a war: applicants in the said group are not potentially entitled by reason of military or naval service in itself; they must have been discharged for disability incurred in line of duty, or they must be in receipt of a pension for service-connected disability.

I have earlier stated that applicants discharged from the present armed forces are not acceptable for hospital treatment or domiciliary care by the Veterans' Administration unless they had been separated from the service for disability incurred in line of duty, or were in receipt of a pension for service-connected disability. A recent development has materially affected that existing eligibility requirement. I refer to the passage by the House of Representatives, on October 5, 1942, of H. R. 7311, a bill which authorizes for persons who served in the present Army or Navy the same benefits of

hospital treatment or domiciliary care which are provided for persons who served in the World War. That is to say, persons who served in the present conflict with the Axis Powers are to have the status of a "veteran of a war"; and this would mean a waiver of the present requirement that, to be entitled to hospital treatment or domiciliary care by the Veterans' Administration, such applicants must have been discharged for disability in line of duty to be in receipt of a pension for service-connected disability. The effect of this proposal, if it be finally enacted into law, would be felt mainly upon the provision of hospital treatment or domiciliary care for disabilities not due to military or naval service. Millions of possible beneficiaries would be newly created who, because of a status as "veteran of a war," would be potentially entitled to such hospital treatment or domiciliary care at any time in their lives, provided they meet what are the liberal eligibility requirements defined in Public Act No. 141, 73rd Congress, March 28, 1934. Those requirements do not exact an honorable discharge; a discharge not dishonorable will suffice. And, if the applicant states under oath that he is unable to defray the necessary expense of hospitalization or domiciliary care, including the incidental transportation, he can be supplied either such benefit. Moreover, there is no delimiting requirement as to the nature of the condition causing his disability: the said Act broadly provides that the applicant may have a "disability, disease or defect." It will be evident to you that if H. R. 7311 be incorporated in the statutes, our whole program of future construction will be notably affected thereby.

As you may well surmise, we are especially concerned about the procurement of sufficient personnel to operate the greatly enlarged medical service which we are envisaging. Out of our earnest desire to co-operate as fully as possible with the Surgeons General of the Army and Navy, we have released a large number of reserve officers — physicians, dentists and laboratorians, particularly. There has been a drain upon our nurses also; while it has been extremely difficult to hold or to procure hospital and mess attendants, not only because of the demands of the armed forces, but also because

we cannot offer salaries to such personnel that would at all compare with the high wages they can get in industrial plants. Since the Veterans' Administration is peculiarly *en liaison* with the armed forces; since it must be ready to take over the disabled soldiers, sailors and marines who will come to it from the armed services, the Veterans' Administration must go on. To make this possible, an arrangement was made whereby our professional personnel received Army commissions, but were placed in inactive status, to carry on their essential duties with the Veterans' Administration. To fill vacancies created by death, retirement, resignation, etc., we must, as you no doubt know, make appointments from registers of the United States Civil Service Commission. Whether that reservoir (which, of course, is also being drawn upon by other Federal agencies) will furnish sufficient replacements to fill vacancies, and supply enough personnel to take care of an expanding patient-load, remains to be seen. With the concurrence of the Civil Service Commission, we may have to adopt other expedients to meet a situation if it threatens to become critical. The cessation of hostilities will, it is thought, ease our difficulties somewhat. To operate the additional hospital beds that may by that time have been created, and to take care of such further additions as may be called for after the end of the conflict, we are looking forward to a repetition of what happened after the 1917-1918 war, that is, that physicians, dentists, laboratorians and other necessary personnel may, upon demobilization, be attracted into the service of the Veterans' Administration.

OCCUPATIONAL THERAPY FOR THE WOUNDED

By G. R. GIRDLESTONE, F.R.C.S.
Hon. Regional Consultant in Orthopaedic Surgery to the Army; Regional Orthopaedic Consultant, E.M.S.

In works of labour and of skill
I would be busy too;
For Satan finds some mischief still
For idle hands to do.—*Isaac Watts.*

A mind quite vacant is a mind distressed.—*William Cowper.*

We can divide rehabilitation into five processes which in their turn accompany the reaction, the healing and recovery of the tissues of a seriously wounded man. These are as follows:

(1) Rest.
(2) "Diversional" occupation } Occupational therapy.
(3) Therapeutic occupation }
(4a) Reconditioning, leading to (4b) Vocational training leading to
(5a) Duty. (5b) Employment.

Rest

A brief period of sheer laziness rightly follows a wound, an accident or a severe operation, and is as natural and wholesome as sleep is to a tired dog. While peace is the best medicine for shock and pain, only those who have had personal experience can fully appreciate its virtue. Nevertheless, the time soon comes when renewed activity is welcome, with its restoration of the circulation, the tone, and the well-being of body and mind. It is for the surgeon to decide how long each individual should vegetate: the less the shock, the younger and tougher the man, the briefer this period will be.

"Diversional" Occupation

In the course of a few days or weeks the shock, toxæmia and asthenia following a serious wound or accident pass. Then in many

a patient there comes a positive desire for something to do; such men present no difficulty to the occupational therapist. Others remain slack and disinclined to make any sort of effort, and demand the most friendly and tactful approach. But in every case something must quickly be found which will attract the patient, prove well within his powers, and throw little or no strain on the damaged part (Fig. 1).

However "diversional" this occupation may seem to be, it is

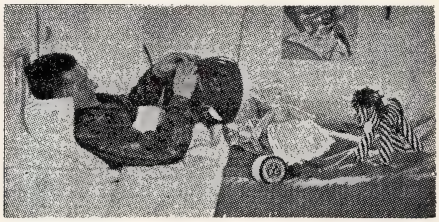

FIG. 1. "Diversional" Occupation. Toy-making from rag-bag material. A popular ward occupation.

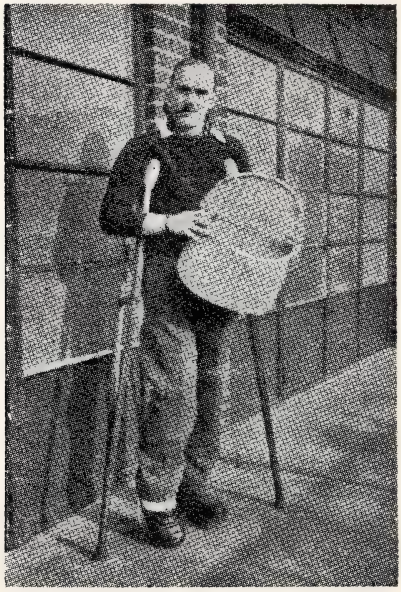

FIG. 2. Basketry was prescribed as treatment for this man's fractured forearm, and it was not until his hobby of fishing was disclosed that he was found at all cooperative.

genuine therapy, and nothing better can be prescribed at this stage. For while the occupation "diverts" the patient's mind from sensory broodings it "adverts" it to his job, whatever the latter may be. Even at this stage the occupational therapist will do much more for the man than merely provide him with some occupation. She will get him thoroughly interested in making something he regards as really worth while. It may well be that only a sympathetic exploration of a man's affinities will disclose some desirable object (Fig. 2). If a man's interest can be fully engaged by the occupational therapist at this stage he is her willing subject for the duration of his stay, to the great benefit of himself and his neighbors.

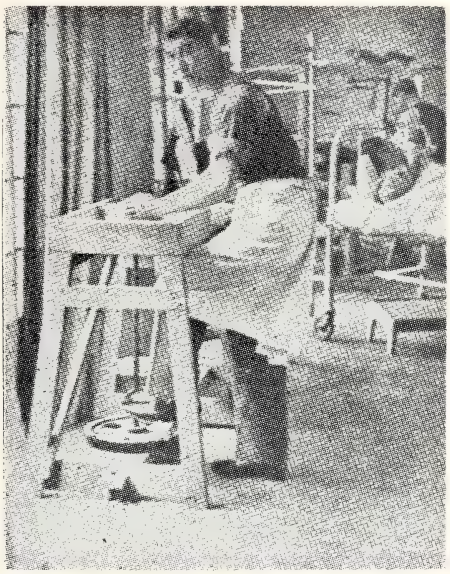

FIG. 3. Pottery on a foot power wheel has dual purpose action of hands and feet.

Therapeutic Occupation

While all occupation is therapeutic it is often possible to prescribe some specific occupation which will gradually and increasingly engage the coordinated activity of the disabled part: in doing this the occupational therapist, as a student of living anatomy and a

technician in the handicrafts, exercises her highest function (Fig. 3).

The surgeon, too, has his part to play. He alone can know how long and hard the man should work, and how great a share in that work the injured part should take. Surgeon and occupational therapist should conspire, and their conspiracy should always be imbued with common sense, for only common sense will protect them from futilities such as putting a man with a recently sutured nerve to a craft requiring delicate touch and fine coordination. This sort of folly creeps in straight from a text book on occupational therapy — a prescription for a nerve injury without the saving grace of sense or any understanding of whys and whens: foolish now, maybe, but excellent a year or two later when sensation and muscular control will have returned and need just such a delicate job for their re-education. In general, the man and his limb will gain most from an occupation which is not only interesting but demands close attention so that he forgets his injury as he masters difficulties and gains greater skill from day to day in the technique of his craft (Fig. 4).

FIG. 4. Glove-making in all its branches is interesting and requires skill.

Occupation is good but the making of something worth while is better, and best when it involves the increasing use of the damaged part. Active use means an active circulation, and natural use of a limb in the presence of active hyperæmia means the reconstruction (or re-identification) of what is anatomical and the hypertrophy of what is useful. The same process brings about the absorption of those tissues which are not constituents of the normal anatomy and which do not serve the function of the limb — John Hunter spoke of these unwanted tissues as possessing ". . . consciousness, in the part to be absorbed, of the unfitness or impossibility of remaining under such circumstances, whatever they may be, and therefore they become ready for removal, and submit to it with ease."

Value of the Skilled Occupational Therapist

Again, it is a profound mistake to peg a man down to the persistent use of a badly damaged hand or limb in some narrow repetitive task. Nothing can be more discouraging or lead more surely to a sense of inferiority and frustration. In truth the wise occupational therapist knows that only a minority of men need authentic occupational therapy prescriptions. She can do far more to quicken the recovery of the majority by getting them all keenly working at a few constructive crafts. These will be chosen for their interest, and crafts which will produce something useful or beautiful will be preferred. From these stock occupations she will select for each individual that which will be most helpful (Fig. 5). It is delightful to see the excellent technique of the skilled occupational therapist. Illustrations can do little more than suggest the way in which the work can be adapted to the disability.

For practical purposes occupational therapy includes every sort of occupation, from so-called "diversional" (a stupid name since, as we have seen, it conveys but half the truth) to occupational therapy *in excelsis,* such as when a loom has been so set up that the man is persistently induced to try to do something just not out of reach. Between the two extremes lie the standard popular occupations in the doing of which many men benefit from regular hours

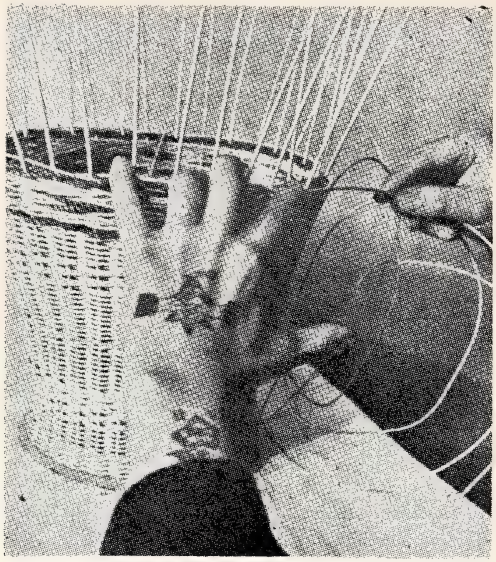

FIG. 5. Basket-making is most constructive and a useful craft when finished. Muscular effort can be graded according to weight of cane used.

of effort and attention and the affected limbs from continuous activity and hyperæmia; and all the time the damaged part is imperceptibly playing a more natural part and gaining in range and freedom of movement.

The service of occupational therapy to the men in hospital owes as much to the good sense, the character, intelligence and personality of the occupational therapist as to her knowledge of anatomy, of handicrafts and of their association. What qualities count in an occupational therapist? First, a great faith in her profession. Secondly, a joy in craftsmanship, for the men must catch and share this feeling. Thirdly, a capacity for quick friendship, and fourthly, a generous readiness to give time and trouble to understand each individual. There can be no compulsion since disciplinary powers are neither available nor desirable. Men in hospital are not sheep but they can be good children in a good Montessori school. They resent persuasion but will follow a leader. Such is the spirit of the game.

Can We Do Without Occupational Therapy?

After a severe wound or fracture a man does not automatically become fit for convalescent depot or a return to duty. Occupational therapy, amateur or professional, is a sheer necessity. Things are often even worse in the case of industrial accidents, particularly for the man without initiative who, discharged from hospital, just sits about at home and glooms. We all know only too well what can happen to such a man. How at the end of a few months he can become a pitiful human wreck breaking into a cold sweat under the kindest examination, and quickly out of breath from causeless anxiety. It is as if the modern devil, sophisticated by Act of Parliament, no longer finds light work for idle hands to do.

CRAFT ANALYSIS IN OCCUPATIONAL THERAPY

By G. D. KERSLEY, M.A., M.D., M.R.C.P.
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Occupational therapy has been defined as the application of occupations, crafts or trades for their therapeutic effect on the rehabilitation of the mentally or physically unwell, and in assisting the process of return of such individuals to a state of health in which they will be of the maximum benefit to the community. Lord Horder reminds us that we must "divert, re-educate and re-occupy both mind and body," and this really sums up the aims of occupational therapy.

History and Development

The value of occupation of the mind has been recognized since the time of Galen; it was largely used in Great Britain as a form of mental treatment as early as the eighteenth century. The physical aspect received its first impetus in the war of 1914-18, but in Great Britain a firm footing was never gained. In America the first school was founded in 1915, and a number of others followed, those at Philadelphia, Milwaukee and Toronto being perhaps more interested in the physical and orthopædic aspects than the remainder. In Great Britain there has been an increasing interest taken in the subject during the last ten years, and in 1936 the British Association of Occupational Therapists was founded. Until the beginning of the present war, however, this Association was encouraged mainly by the psychologists, and naturally the early development was more advanced in this field. During the last two years there has been a *volte face,* and the whole country has been clamouring for occupational therapists trained in the physical aspect, the demand being so great that both the Dorset House School (which takes trainees for the E.M.S.) and the army school have adopted the policy of

training masseurs or masseuses in occupational therapy, in order to shorten the training and meet the demand. With this policy the basic training in anatomy, physiology, pathology and kinaesthetics is thereby shortened

Advantages of Occupational Therapy

Physical methods have altered in relative popularity. Massage and sparks gave way to a vogue for remedial exercises; orthopædic surgeons were heard to mutter prayers for the preservation of their patients from passive manipulations. The active movement cult now shows a tendency to adopt occupational therapy as its deity, causing Brigadier Howitt to sound a note of warning of "the danger of loss of perspective in relation to other physical methods." Occupational therapy, looked upon as a means of producing active movement, has advantages over remedial gymnastics in many cases of physical disability, especially in so far as the upper limbs are involved, and in later stages of treatment. Remedial exercises score in that little, if any, apparatus is required, that some movements may be more exactly localized by specific exercises than by prescribed occupational therapy and that persons of a certain type of mental make-up do best by concentrating on producing an improvement of the disabled part. Many others, however, soon become bored with performing, what are to them, purposeless movements. There are few cases of longstanding disability in which sooner or later the mental factor does not creep in, and by interesting an individual in a craft, hobby or trade which will at the same time benefit his condition, the best result is often obtained. It is well recognized that in the less severe forms of exercise mental fatigue manifests itself long before physical fatigue does so and by reducing the former element the length of individual treatments can be extended; at the same time the painful or restricted movement is carried out with the minimum of concentration on the injured part, and is introduced in conjunction with other body movements in the way it will eventually have to be used in normal life.

Suitable Routine of Treatment

When a patient is seen who is expected to benefit by occupational therapy, the medical adviser should write a prescription containing a brief account of the condition to be treated, the movements to be encouraged, the restrictions to be imposed, and any other relevant data. When seen in the occupational therapy department, the individual himself must be assessed as regards his mental capabilities, education and volition, for if he has no interest in the project selected, the personality of the instructor or instructress will have to bear the full brunt of engendering this interest. Next, the physical aspect must be considered and a project selected, which, while being compatible with the mental attributes of the patient, will conform to the requirements of the prescription. This requires a detailed knowledge of craft analysis: below, an attempt is made to show how this is to be achieved. A sound knowledge of kinaesthetics is necessary for an intelligent appreciation of the subject, but apart from this and until considerable experience has been accumulated, some "catalogued" analysis is helpful. Three types of analysis charts have been utilized, one for detailed analysis of the effects and uses to which a particular tool in a craft may be put, a second for a less detailed analysis of the principal value of a craft as a whole, and the third for classification of crafts according to specific disabilities for which they may be utilized. The first is illustrated by the analysis of the movements produced in the use of certain tools in carpentry, as detailed in Appendix A; the others are dealt with in Appendices B and C. Careful follow-up notes are most valuable, and headings for a suggested form for prescription and note keeping are included in Appendix D.

Main Principles of Occupational Therapy

Before detailed analysis is dealt with, mention should be made of certain principles which must be appreciated. The work done may be subdivided into primary and secondary movements and static work. The majority of the movements in occupational therapy are "resisted," but in some cases they are "assisted," as instanced by the

movement of the left elbow and shoulder in right-handed planing. "Secondary" movements, such as that of the left knee and ankle in long-range planing, may be of great value, especially as the patient does not realize that this is an intended part of his treatment. Static work is in many cases an important factor; for example, the use of the gripping muscles in planing is quite strong, and may be either beneficial or harmful according to the condition under treatment. Static contraction without frequent relaxation is particularly undesirable in rheumatic conditions, and in all cases rhythmic relaxation between movements should be encouraged. A watch must be kept for "trick" movements to avoid the use of a painful or stiff joint, and this introduces the great importance of position of work. Thus the action of driving in screws with a flexed elbow is pure pronation and supination, but with the elbow straight, as in screwing downwards on an object on the floor, rotation of the shoulders plays a large part. Moreover, posture is of extreme importance, and whereas in a round-shouldered individual, leaning forward over a loom may be really harmful, lying on the back on a mattress under a specially constructed loom, and stretching upwards may be very beneficial. An experimental loom of this type is illustrated in Fig. 1.

Alteration of Apparatus. — There is an infinite field for

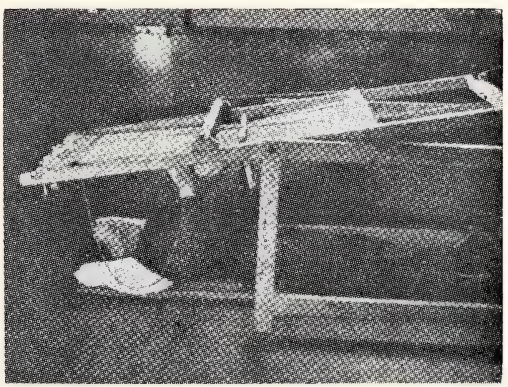

Fig. 1. Loom constructed to increase range of abduction, for kyphotics and recumbent patients.

development of apparatus by alteration in loom controls to produce specific movements, additions of resistances to increase muscle work and other changes. Recently an old Zander passive ankle roll apparatus was altered, the handle being removed, the camber of the turn-table being changed, and the table covered with felt. It is now in use for polishing leather or winding bobbins, and requires strong active anterior and posterior tibial work for its operation. (Fig. 2.)

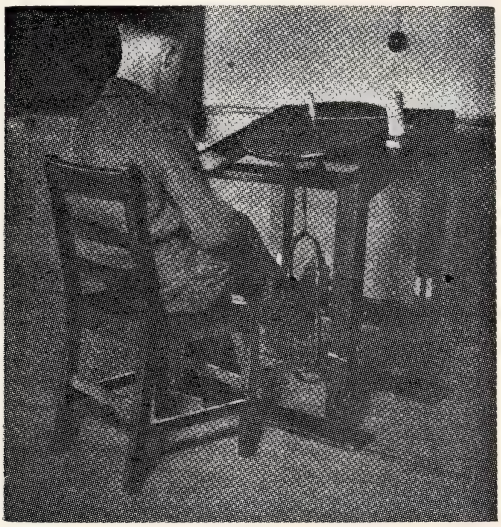

FIG. 2. Zander foot roll apparatus adapted for active use of anterior and posterior tibial muscles and flat foot cases. Can be used for polishing leather and buckles or winding bobbins.

GRADUATION OF EXERCISE. — Graduation of exercise may be carried out in various ways, for example by choice of craft. Gardening or tree felling, and log sawing may be used as the final stage of rehabilitation, necessitating heavy work in the fresh air. The project may be chosen to necessitate varying proportions of the desired movement, much or little use of the injured part being necessary. Again, the material and tools may be altered in hardness or weight, more "resistance" weights may be added to the apparatus, and the range of movement increased. The last may be achieved by encour-

aging a larger sweeping planing or altering the length of the pedal shank in the bicycle saw.

GAMES — Finally the value of games for remedial purposes must be remembered. At Mr. H. E. Griffith's Occupational Therapy Department at the Seamen's Hospital, Greenwich, these are the most important feature.

IMPROVISATION. — Against the expense incurred in using occupational therapy must be put the advantage to the individual in learning a new hobby or trade, and if care is taken, the expense itself can be greatly reduced by use of scrap material and by manufacture at home of simple apparatus. In a recently started centre thirty small looms for weaving were rapidly made from scrap wood in the occupational therapy carpentry shop, and the metal work department was supplied with its expendable material from scrap tins cut and rolled in the department, and from scrap lead from derelict roofing. A sandpapering machine is easily constructed from an old treadle sewing machine base (Fig. 3), and the most elaborate toys and models can be made from scrap material. In Fig. 4 is illustrated a working model of a windmill. The sides were made of

FIG. 3. Sandpapering machine made from old treadle sewing machine base.

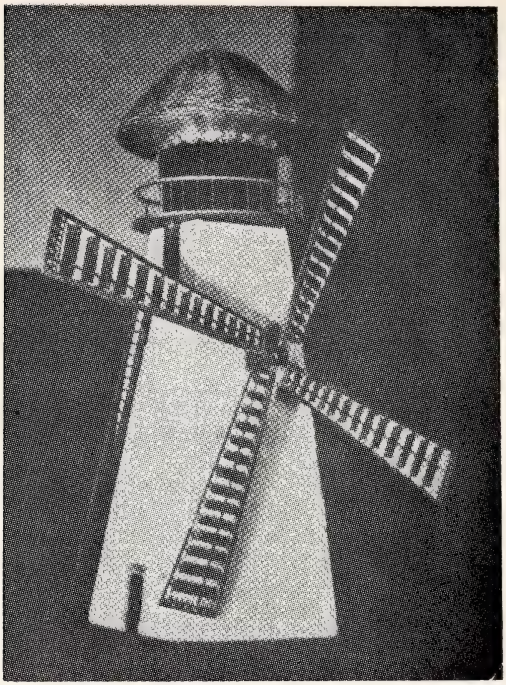

FIG. 4. Model windmill made from scrap material. Working model.

cardboard, coated with glue, and then sanded and finally painted to produce an excellent stucco effect. The top was made from reed and the model was worked by sand running from the top of the tower to a drawer at the bottom. It was made by a student from his own design, and without any previous training. Willow basketry has proved a useful progression on reed basketry, and the materials are more easily obtainable and less expensive than the more commonly used reed.

DISPOSAL OF ARTICLES. — When an article is finished the patient should have the option of buying it at cost price plus a small percentage added to cover wastage, and articles not purchased in this way may be disposed of at a sale, or if unsuitable for sale, may be ripped to pieces (without the knowledge of the patient concerned) and the materials used again. The value to the outside world of the finished project is of little importance, but the value to the indi-

vidual making the article should be as high as possible. It is impossible to exclude the psychological factor in any patient, and every effort should be made to ensure that he produces work that will give himself satisfaction.

Occupational Therapy and Rehabilitation. — By care in selection and complete utilization of materials, occupational therapy may be an inexpensive and very useful adjunct to physical medicine, and should play an important part in rehabilitation. As a form of active movement and with a purpose it links up with medical gymnastics and takes the patient a stage further towards complete recovery.

I wish to express my thanks to the staff of the Army Occupational Therapy Centre and to the O.C. 114 Convalescent Depot for assistance and facilities in carrying out this work.

Appendix A: Movements Produced By Carpentry Tools

Carpentry is of great value, as, on account of the great variety of projects and tools, almost any movement can be obtained. It is an absorbing hobby for patients who are up—provided they do not have suicidal or homicidal tendencies—and may require little or much physical energy. Moreover, the department is of value for its assistance in manufacturing apparatus for other parts of the occupational therapy centre. The tools necessary, however, are expensive, and unless scrap wood can be used this is also a source of expense. It should be noted that while planing is dealt with in full, in the case of the remainder of the tools an abstract of the analysis only is given. It must also be recognized that these analyses are of the usual movements and work entailed in plying a craft, but that there are various alternatives depending on the position of the work and the idiosyncrasies of a particular individual.

(1) Plane

A. *Moving Joints: Primary Movements*

(a) *Right shoulder.*—Movements: flexion and extension. Main muscles: pectorals and anterior deltoid; latissimus dorsi, teres major and posterior deltoid.

(b) *Right elbow.*—Movements: flexion and extension. Main muscles: brachialis, brachioradialis and biceps; triceps.

(c) *Spine.*—Movements: flexion, extension and rotation. Main muscles: abdominals and spinati.

B. *Moving Joints: Secondary Movements*

(a) *Both shoulder girdles.*—Rotation, especially serratus anterior.

(b) *Left shoulder.*—Flexion with abduction and extension with adduction.

(c) *Left elbow.*—Flexion and extension.

} May be passive or assisted.

(d) *Both hips.*—Flexion and extension.

(e) *Left knee.*—Flexion and extension.

(f) *Both ankles.*—Flexion and extension.

C. *Static Work*

(a) *Grip.*—All muscles of hand and forearm and especially wrist extensors.

(b) *Upper spine.*—Extensors.

D. *Clinical Application*

(a) Building up muscles of right upper extremity.

(b) Increasing range of movement of both shoulders and elbows.

(c) Re-education of grip.

(d) Building up of trunk muscles.

(e) Increasing movement of left knee and ankle (with long-range planing).

Planing is necessary for the majority of carpentry projects. Long-range planing figures largely in crutch making.

(2) Bicycle Fretsaw

A. *Joint Movements: Primary*

(a) *Ankles.*—Plantar flexion and dorsiflexion (largely passive).

(b) *Knees.*—Flexion and extension.

B. *Joints Movements: Secondary*

(a) *Hips.*—Flexion and abduction, extension and adduction.

C. *Clinical Application*

Mobilizing ankles, knees, hips and building up quadriceps.

Notes.—Height of seat and length of shank of pedal can be modified on either or both sides, affecting degree of knee flexion. Pedals may be wedged to produce inversion, and the foot is best strapped to the pedal.

(3) Chisel

This may be used in three ways, cutting downwards, horizontally or with a mallet.

A. *Cutting Downwards*

This may be done entirely by body movement, using flexion, extension, and rotation of the trunk with static contraction of the right triceps, gripping muscles (bilateral) and fixators of the shoulder and right shoulder girdle, or with some active extension of the right elbow joint. It is of value for certain lesions of either hand, to build up muscles of the right arm and shoulder, and for coordination.

B. *Cutting Horizontally*

This involves flexion and extension of the right elbow, and flexion and extension of the right shoulder, and requires strong, restricted and controlled movement of the hands and right wrist.

C. *Using a Mallet*

This involves mainly flexion with adduction and extension with abduction of the right wrist and bilateral grip.

(4) Sandpaper

Sandpapering causes strong flexion and extension of the shoulder, and flexion and extension in pronation of the elbow. Either arm can be used. There is also strong static pronation and extension of the supporting arm and strong grip with opposition, and adduction of the thumb. This form of occupation is also useful for late median nerve injury and other analogous lesions.

(5) Screwdriver

This brings into use pronation and supination of the right forearm and adduction and flexion of the right shoulder. If the arm is vertical with the elbow straight, internal and external rotation of the right shoulder is produced. For pronation, left-handed screws can be used. Patterns may be made with screws for decoration. This is useful for Colles' fracture and similar conditions.

(6) Hammer

The use of a hammer causes adduction and abduction of the wrist and flexion and extension of the elbow. There is also grip of the right hand and opposition of the left thumb and first finger. Embossed patterns may be made. This is valuable for the right hand, wrist and forearm, and for opposition of the left thumb and first finger (median nerve injury) and coordination. Jarring may however make the use of a hammer unsuitable for a recent injury.

(7) Spokeshave

This requires similar use of both arms.

A. *Planing Concavity Away from the Body*

This involves extension of the wrist, pronation with extension of the elbow, and adduction of the shoulder. It is especially useful for drop wrist.

B. *Planing Convexity Towards the Body*

This involves flexion with adduction of the wrist, supination with flexion of the elbow, and abduction of the shoulder.

In both methods there is bilateral use of grip, opposition of thumbs and contraction of abdominal and leg muscles.

(8) Bit and Brace

This allows flexion and extension of the elbow and circumduction of the shoulder. Static contraction of the abdominal muscles is also produced. The use of this tool is valuable for mobilizing the elbow. It is used plentifully in making Chinese checkers boards.

(9) Drill

The use of this brings about circumduction of the right wrist and all movements of the elbow. This form of occupation, which is used for making a cribbage board, is useful for mobilizing the wrist and strengthening the muscles of the forearm.

(10) Saw

Associated movements are flexion and extension of the right shoulder and elbow and the spine. This tool is used in static work for grip and back muscles, and for building up the muscles of the trunk, of the right arm and of grip, and for mobilizing the right shoulder. It is also used with long planing for the left knee and ankle.

(11) Treadle Fret Saw, Lathe or Sanding Machine

The use of these causes plantar flexion of the forward foot and dorsiflexion of the rear foot. The relation of the spindle to the treadle varies the degree of plantar- or dorsiflexion. Foot plates may be wedged for inversion. The use of these tools is especially useful for Pott's fracture.

Appendix B: Complete Craft Analysis

Below are examples of simple but fairly complete craft analyses. It must be realized, however, that many of the physical processes involved can be modified by the position of the patient in relation to the project. Knotting is dealt with in full, but the other crafts are not given in such detail.

(1) Knotting

A. *Economic Factors*

(a) *Need for apparatus.*—A simple frame can easily be made, or a picture frame will serve the purpose.

(b) *Availability of materials.*—Macramé twine is the best material, but there is some shortage of it. Any waxed twine can be used.

(c) *Saleability of product.*—There is a good sale.

(d) *Amount of instruction necessary.*—The cutting of the twine should be supervised in order to prevent its being wasted. The knots are simply learned, and the patient can do most of the belt without supervision.

(e) *Adaptability.*—This occupation is suitable for men, women, or children, in bed, in the ward or in the workshop. It is a particularly good craft for men. It is especially suited to normal or lower grades of intellect.

B. *Physical Processes*

(a) *Both upper limbs.*

(b) *Shoulder.*—All movements are especially good if the patient is not allowed to shorten the twine by rolling it up.

(c) *Elbow.*—Flexion and extension.

(d) *Forearm.*—Pronation and supination.

(e) *Wrist.*—All movements, especially flexion and extension.

(f) *Hand.*—All movements strong.

C. *Mental Processes*

(a) *Interest and variety.*—Little variety is possible, but interest lies in the process as well as in the completed article.

(b) *Concentration.*—Not great.

(c) *Initiative.*—In arrangement of knots and choice of colour.

(d) *Coordination.*—Moderate.

(e) *Stimulating effect.*—Dependent partly on colours; does not tend to become monotonous during the construction of the first belt; can have a quietening effect for the over-excited or restless patient.

(f) *Physical activity.*—The strings must be pulled fairly hard, and this is often a relief for mental patients.

D. *Clinical Application*

(a) *Indications.*

Trauma to either upper limb; especially for weak grip.

In recovery of deformities of the hand due to nerve lesions.

For certain types of mental patient.

To train coordination.

In certain arthritics.

(b) *Contra-indications.*

When the skin of the hand is tender, the string is apt to cut.

In suicidal ward of a mental hospital, unless the patient is supervised constantly (danger of hanging).

(2) Basketry

A. *Basketry—Reed* (*Light Basketry*)

Few tools are necessary, but cane is scarce. Water must be easily available for soaking the cane.

(a) *Physical processes.*—Bilateral use of upper extremities, involving all movements of the fingers and thumb, wrist (especially if long weavers are used), slight pronation and supination, elbow flexion and extension, and all shoulder movements. There is static work for the left hand and wrist in starting the work. This part is rather cramping and should not be applied to rheumatic patients.

(b) *Indications.*—Early treatment for injury of either upper extremity—

light work with a good range. Used for arthritic cases, mental disorders, blind patients and coordination.

B. *Basketry—Willow* (*Heavy Basketry*)

Little apparatus is needed for this, and willows are grown in Great Britain. This occupation is a useful progression on light basketry. It provides very strong grip work and is a good outlet for certain over-active mental patients. "Knocking down" with the hand contra-indicates its use in any condition resulting from recent injury.

(3) Weaving

This is of value owing to its safety and the ease with which looms may be adapted to serve various purposes. A simple loom may be made in the carpenter's shop for a few shillings, but some types are very elaborate and expensive. The mechanism of raising the heddle may entail (1) use of the lower extremities; (2) lifting by a cord for extension of the wrist; (3) turning a roller by means of an upright handle for abductors and adductors, of a vertical handle for flexion and extension of the wrist, or of a wheel for pronation and supination; or (4) a low lateral control for scoliosis and "back" cases.

The beating may be carried out by a weighted bar towards the individual for flexion, or upwards for shoulder abduction with extension, or it may be done with the fingers in extension upwards or flexion downwards. The posture (sitting and bending over, standing in front of, or lying under, the loom) is of great importance.

A. *Weaving—Two-way Loom*

This apparatus is inexpensive, but a permit is required for 3-ply wool.

(a) *Physical processes.*—Active movements of the fingers and thumb in tying, lifting the heddle, passing the shuttle and beating. There is some pronation and supination with flexion and extension of the elbow, and also abduction with flexion in raising the heddle and passing the shuttle, and extension in beating towards the patient. There is static work for the extensors of the wrist.

(b) *Indications.*—Injuries of upper extremity, drop wrist, coordination, certain arthritics, and suicidals.

(c) *Contra-indications.*—Active T.B. and mental cases with confusion.

B. *Weaving—Foot Loom*

The apparatus is elaborate and expensive.

(a) *Physical processes.*—Bilateral craft—flexion and extension of ankle, knee, and hip. Movements of the trunk and shoulders (especially abduction with long shuttle), elbows, pronation and supination and light grip exercises.

(b) *Indications.*—Mobilizing upper and lower extremities and coordination.

C. *Weaving—Card*

The apparatus is easily made, the materials available and inexpensive.

(a) *Physical processes.*—Use of both hands and strong extension exercise for index finger, also use of the wrists, elbows and shoulders, especially abductors and flexors in the last.

(b) *Indications.*—Patients must have good intelligence, coordination and concentration. Especially useful for extensors of index finger and pronation and supination.

(4) Rug Making

This is a useful craft as it requires little apparatus, and is easily adaptable for bed patients. The variety of types of rugs allows for many different movements.

A. *Rugs—Woven*

The apparatus needed is an easily made frame. Materials have become scarce, but "thrums" are inexpensive. Used for all upper extremity movements, especially finger extension in beating. Can be used for certain arthritics, and is good for finger exercise.

B. *Rugs—Donegal Knotted*

These need a rug hook and canvas. Rug wool is difficult to obtain, but "thrums" can be used. This form of occupation is indicated for mental patients—bright colours and intricate designs for depressives, simple with quiet colours for maniacs and suicidal cases (hooks safe). It is also useful for mobilizing the hand, wrist or forearm, and for coordination, as well as for the blind.

C. *Rugs—Braid Woven*

These need a simple frame and are economical, dyed scraps of material being used. They provide light movements for the hands, fingers and wrists, and static work for the shoulders and elbows. This is a useful occupation in hand cases, when the patients may have their hands in plaster, in mental cases and for the blind.

D. *Rugs—Turkish*

These require a loom, or can be made on a frame with shed sticks. Many materials are suitable—a string for the warp, and wool or cotton for the weft. They provide strong work for the finger and thumb in knotting, flexion and extension of the wrist and elbow, with extension combined with adduction and abduction of the shoulder in beating. Used for mobilization and coordination of the upper limb, and for mental cases.

(5) Leather Work

Leather work involves modelling, assembling and lacing. A few tools are necessary. Leather, except scrap, is becoming scarce. The craft provides

work mainly for the right upper limb—flexion and extension of the fingers in cutting and punching; wrist flexion, extension and circumduction in tracing; and pronation and supination in thonging. There is static work for the fingers and thumb in modelling and tracing. Useful for flexion of fingers and opposition of the right thumb, also for T.B. cases and neurotics. Not suitable for careless patients, overactive mental patients or arthritics.

(6) Chip Carving

This needs one knife only and a small piece of wood. The work is mainly static for both hands.

(7) Metal Work

Tools are required and are difficult to obtain. Metal, unless scrap is utilized, is similarly scarce. Metal work is a fascinating craft for men in workshops. Useful splints, leg irons, etc., may be made. The main work is for grip, and for abduction and adduction of the wrist, and extension and flexion of the right arm in hammering, planishing, etc. This work can be very heavy. Filing and the use of a hack saw gives flexion and extension of the elbow in pronation. The use of the tinman's snips is a strong gripping exercise with alternate relaxation. The craft is valuable for coordination.

(8) Vegetable Gardening

This is a good example of hardening and outdoor work with high utility value. The tools required are few and easily obtainable, and rough land is often available. It is a valuable occupation for those requiring fresh air, and may follow on in rehabilitation after certain lighter indoor crafts. Many strong movements are entailed, and the exact muscle-joint action varies to some extent with the individual's method of work. A few important movements only are analysed below.

A. *Digging*

On inserting the spade and fork there is strong work for the extensors of the hip and knee, and for the abdominal muscles. On lifting the earth the task falls to the depressors and flexors of the right shoulder and extensors of the right elbow, to the elevators, serratus anterior and trapezius of the left shoulder and flexors of the left elbow, the bilateral grip muscles and the extensors and rotators of the trunk.

B. *Forking Over and Weeding*

In addition to utilizing the depressors of the right arm, the elevators of the left arm, and the back muscles as above, this brings into play strong supination and pronation of the right forearm.

C. *Use of the Trowel*

This produces strong adduction and abduction of the right wrist with flexion and extension of the elbow.

D. *Wheeling a Barrow*

This introduces bilateral lifting with the arms, extension of the trunk, strong abdominal and pectoral work, and the use of the extensor muscles of the legs.

E. *Hoeing*

As pointed out in Bowen and McKenzie's *Applied Anatomy and Kinesiology* (p. 340), this illustrates how one group of muscles takes over as another tires. Apart from extension and flexion of the elbows there is strong abdominal work, and as these muscles tire the workman stoops in order to use the weight of his body until his back extensors begin to ache, when he straightens his back and the abdominals again take over the brunt of the work.

(9) Games

Games may be used as part of the occupational therapy programme with great advantage. They act as a change from work on a project, and may be the means of gaining the interest of an individual who does not at first take kindly to other forms of occupational therapy. A few games of special value may be mentioned.

A. *Draughts*

This is played on the floor with small squares and using the inside or outside of the foot is useful for inversion or eversion, and especially for coordination. It is played with weighted boxes on the floor for back exercise.

B. *Darts, Quoits and Table Tennis*

These are useful for leg and foot exercise and for all movements of the upper extremity and for coordination, especially of the wrist and forearm.

C. *Dodge Ball*

This is played in a circle, using a soft rugby football, for all body, arm and leg movements. A shaped ball calls for more use of the hands in gripping than does a round ball.

D. *Tennis and Badminton*

These games are especially useful for abduction of the shoulder, in addition to other movements.

E. *Cycling*

For leg and trunk exercise.

F. *Swimming*

For all movements.

Appendix C: Crafts for Specific Clinical Conditions or Movements

(1) Both or Either Upper Extremity (All Joints)

Basketry, weaving, Donegal and Turkish rug making, knotting, digging, hoeing, etc., sandpapering, planing, sawing, and the use of the spokeshave. Table tennis, dodge ball, and swimming.

(2) Right Upper Extremity

Leather work, painting at a height and warping. Tennis and badminton.

(3) Hands and Fingers

A. *Strong Work*

Sandpapering, knotting, Turkish rug making, willow basketry, metal work and digging.

B. *Light Work* (*can be done with arm in plaster*)

Braid woven rugs, weaving, glove making and reed basketry.

C. *Extension of Fingers*

Card weaving, weaving, Turkish rug making, piano playing, typing and flick shove halfpenny.

D. *Flexion of Fingers*

Leather work (with padded handles of tools if necessary), knotting, use of tinman's snips, piano playing, typing and plasticine modelling.

(4) Wrist

A. *Extension and Flexion*

Hammering, metal planishing, weaving (two-way loom), knotting, use of spokeshave, piano playing and typing. Table tennis, darts and quoits.

B. *Adduction and Abduction*

Hammering, planishing and use of trowel.

C. *Pronation and Supination*

Card weaving, warping, weeding with a small fork, sandpapering (pronation), and use of drill, spokeshave and screwdriver.

(5) Elbow and Shoulder

Planing, sandpapering, sawing, use of screwdriver, spokeshave, brace and bit, hand fret saw, canework (with long weavers), weaving and knotting with long thread, warping and painting large surfaces. Tennis, badminton and billiards.

(6) Winged Scapula

Sawing, long range planing, and sandpapering.

(7) Both or Either Lower Limb (All Joints)

Bicycle fret saw, foot loom and digging. Cycling, tennis, table tennis, darts, dodge ball and swimming.

(8) Ankle and Knee

Treadle lathe, fret saw or sanding machine, sawing, planing (long-range) and use of sewing machine.

(9) Feet

Treadle or bicycle apparatus with inversion or eversion wedges, Zander foot roll apparatus adapted as polishing wheel or potter's wheel. Relay races with marbles picked up with the toes, foot draughts and sand boxes.

(10) Trunk Exercises

Sawing, planing, use of bit and brace, chisel, spokeshave, weaving on loom with weighted beater or with loom worked from back-lying position, digging, hoeing, and moving wheelbarrow. Playing with weighted draughts on the floor.

(11) Scoliosis

A loom with low side heddle control should be used.

(12) Coordination

Start with coarse movement and grade carefully. Use of chisel with mallet and hammering if coordination fairly good, knotting, basketry, weaving with foot loom, leather work and chip carving. Foot draughts, table tennis and darts.

(13) Suicidal and Similar Types

Sharp tools, rope and string not allowed. Weaving, Donegal rugs, basketry (but an awl is not allowed), plasticine modelling and glove puppets.

(14) Arthritics

No cramping craft allowed. Braid woven rugs, woven rugs, weaving, cane basketry (in many cases the dampness of the reed does not seem to cause harm) and raffia work.

(15) Blindness

Consider texture, kinaesthetic value and commercial value. Braid woven and Donegal rugs, basketry and brush making.

(16) Head Injuries, Tuberculous and Cardiac Cases

Donegal and braid woven rugs, cane basketry, weaving (other than card weaving if not too intricate a pattern), knotting, leather work, soft toy making, raffia work and painting.

(17) BED CASES

Knotting, leather work, chip carving, painting, embroidery, weaving and rug making, soft toy making and typing.

RE-EDUCATION OF THE WAR WOUNDED

JOHN A. KRATZ, *Director, Vocational Rehabilitation Division, U. S. Office of Education*

Fourteen months after the entry of the United States into the first World War the Congress passed a vocational rehabilitation act to provide for the rehabilitation and return to civil employment of disabled persons discharged from the military or naval forces of the United States. Within one year after the signing of the rehabilitation act, the Federal Board for Vocational Education, which at that time was responsible for the program, had registered 136,049 ex-service men for training or other rehabilitation service.

As the United States enters its second year in World War II the Congress is deliberating on proposed legislation for the rehabilitation of men disabled in the current conflict. Scattered reports of casualties indicate that, regardless of the termination date of the war, large numbers of disabled men will soon present themselves for "rehabilitation and return to civil employment." Common sense calls for the immediate establishment of a program of rehabilitation to provide training and other services to at least 100,000 men during the fiscal year 1943-44 and capable, if necessary, of expansion to serve two or three times that number. In a large measure, the shortcomings of the first soldier rehabilitation program were traceable to organizational difficulties arising from the necessity for speed in organizing and developing training facilities—difficulties that could have been avoided if the program had been started at an earlier date.

It may be hoped that before the termination of this War there will exist a fully organized Rehabilitation Service which already will have drawn plans for marshalling all available resources for providing an effective rehabilitation service to disabled soldiers, sailors, and marines. There is promise that such will be the case. As early as December 22, 1941, the Federal Security Administrator

called, at the request of President Roosevelt, a conference of Government administrators concerned with various aspects of physical and vocational rehabilitation of disabled ex-service men. Throughout the first year of the war, a great deal of study and thought was given to the formulation of plans and the writing of legislation for the proposed rehabilitation program. This planning engaged the attention not only of the administrators of the existing rehabilitation program for civilians but of officials of the Veterans Administration, the Federal Security Agency, the Bureau of the Budget, committees of Congress, and representatives of the organizations of veterans of the first World War.

Evaluation of Assets

Before formulating plans for a new program it is essential to review and evaluate the available assets for developing a unified rehabilitation service. Much of the work during 1942 was devoted to a study of agencies, institutions, and personnel that might be drawn upon in building up a Rehabilitation Service. It is well here to evaluate some of these assets before drawing the blueprints for the basic organization of a Rehabilitation Service.

MEDICAL.—The Veterans Administration, with its Nation-wide development of medical facilities, will provide not only a complete medical service but all needed types of reparative service. They also will provide physical and occupational therapy and all types of prosthetic appliances. Full medical histories can be provided for the benefit of the vocational-guidance specialists, training officers, and placement officers.

PERSONNEL.—Foremost among the assets for developing a sound and effective vocational rehabilitation program is the experienced personnel that may be drawn upon for conducting the work. At present something more than 400 professional rehabilitation workers are employed by the Federal and State rehabilitation divisions. Many of these have had a decade or more of experience in the vocational problems of the physically handicapped. Not a few were employed in the original soldier rehabilitation program. For

example, of the current staff of the Vocational Rehabilitation Division of the U. S. Office of Education seven are veterans of the original soldier program.

Although the 400 workers now employed by State rehabilitation divisions may not seem a large force, as a nucleus it is an asset of extreme importance. Assuming that each experienced worker becomes the leader or supervisor of four new workers, we have a supervisory staff of 2,000 agents — enough to arrange and supervise the training of 100,000 cases.

Not only are there available rehabilitation agents experienced in the all-round phases of rehabilitation of the handicapped. Also available are large numbers of specialists who will be in great demand in an expanded program in which specialized services will be in far larger focus than at present. Included in this group are clinical psychologists, specialists in vocational education, teachers of lip reading and speech correction, workers for the blind, occupational therapists, medical and psychiatric social workers and placement agents.

Training Facilities.—The development of training facilities for practical and effective instruction is a problem of tremendous proportions. Many of the disabled veterans are of meager education and are hardly susceptible to the methods employed by most established training agencies. In 1920, after vocational surveys had been made of more than 150,000 ex-service men, it was reported that "at least 45 percent of the prospective . . . trainees are men of meager education, who need a considerable amount of training to qualify them to carry on in any new line of work. A large percentage . . . need special training in elementary subjects."[1]

After this war, however, the problem should be somewhat less difficult, first, because the majority of the men to be trained will have had a better scholastic preparation than those trained after the last war, and second, because more suitable training facilities are now available.

[1] Federal Board for Vocational Education, *Annual Report, 1920.* Page 383.

From 1920 to 1940 the number of persons graduating from high school increased more than threefold while the population of the country increased by only one-fourth. This indicates that the scholastic background of the ex-service men will be much higher than after the last war. Moreover, many of the men will already have received from the Army intensive vocational training which will carry over into peacetime.

Another encouraging factor may be noted with respect to the colleges and universities. Unlike the situation during the last war, the colleges today are making radical adaptations of curricula and schedules in order to remain open. Many will be devoted entirely to the needs of the Army. Because of this war-time experience it will be far easier than after the last war to induce college officials to establish courses for special students.

A training facility of great potential value is the vocational education schools and facilities—particularly the program of vocational training for war-production workers. After the war is over there will be in the schools a tremendous amount of machines and other industrial equipment that can be used for instructional purposes. Experienced instructors will be available and, perhaps most important of all, the curricula will already be cast in terms of essential requirements for specific types of employment. Also available are the training centers of the National Youth Administration and the facilities of the Training Within Industry Service. When working with trainees of little education much of the training must be "on the job," or what in the last soldier rehabilitation program was called "placement training."

PLACEMENT FACILITIES.—There is now a Nation-wide system of employment offices to provide a placement service to handicapped veterans. During recent years the Employment Service and other agencies have done a great deal of research in job analysis, particularly with reference to the physical requirements of the job and the suitability of disabled persons for such employment. This work will be extremely helpful in making suitable placements.

Drawing the Blueprints

From the foregoing summary it is clear that ample facilities are available for providing a complete rehabilitation service to disabled veterans. The difficulty lies in the establishment of an administrative organization to marshall effectively these varied assets into a unified program of service for the physically handicapped. This was one of the jobs facing the Seventy-eighth Congress when it convened in January 1943. Prior to action by the Congress it is apropos to set forth some general principles to be followed in establishing an organization and to formulate tentative policies for the administration and provision of services.

Use of Existing Facilities.—Obviously it will be a tremendous advantage to utilize fully all existing agencies and facilities for training and other rehabilitation services. These agencies have not only the material facilities for their various tasks but what is more important the experience and specialized knowledge so important in a program of this sort. It should be borne in mind, moreover, that the rehabilitation of ex-service men is essentially a rush job; ninety percent of the program will be concentrated in four or five years following the cessation of hostilities. This aspect of the program is especially important because of the difficulty in training new workers. The work of a general rehabilitation agent is so varied that it takes two years for a new agent, even one with good training and practical experience in a related field, to become fully competent in the work.

A Unified Service.—An equally important principle is that the work should be in the charge of a unified Rehabilitation Service. It is true there are guidance agencies to give guidance, training agencies to provide training, placement agencies to find jobs, and social-work agencies to provide counsel and some types of supervision. The work of a rehabilitation agent, however, is that of an expediter and organizer. He must coordinate the efforts of the participating agencies and services. There must be one person to whom the client can turn for solution of his problem whether it

be one of vocational advice, training, health, personal adjustment, or employment. If the rehabilitation agent is not qualified to solve the problem he should be in a position to refer his client to an expert.

There is also a strong argument in favor of a unified service for both civilians and ex-service men. It is argued by some, however, that a rehabilitation program for ex-service men should be established separately from the civilian program. They make the point that any service which a person gets by virtue of being a veteran, rather than by virtue of being a citizen, should be established and administered apart from similar programs for civilians. There is some weight to this argument since medical and reparative services are concentrated in the Veterans Administration, an agency established to provide numerous services and benefits to veterans. It should be remembered, however, that the rehabilitation program for veterans is temporary. The civilian program, on the other hand, is permanent and will therefore be able to give additional service to veterans in the years and decades after the temporary program has ceased. For example, the civilian program has provided training, placement, and advisement services to thousands of veterans of World War I since the soldier program was terminated.

A more cogent argument for a unified program is the confusion of having two programs operating in the field — two sets of rehabilitation agents making contracts with training agencies and two sets of placement officers contacting employers.

In establishing a unified service it would be expected that the final administrative responsibility would be vested in the Administrator of Veterans' Affairs as well as in the Federal Security Administrator. Logically the policies applying specifically or primarily to veterans should be set by the Administrator of Veterans' Affairs. Though there might be some confusion from a somewhat divided responsibility at the top, this certainly would be more than offset by the advantages of a unified program at the operating level.

ADMINISTRATIVE ORGANIZA'ION.—The operating organization must extend from Washington to the regions where the major administrative authority will be vested. The regions will be divided

into State and district areas which will be the major service unit. Each district may include a number of local offices. In each district there will be at least one fully equipped "rehabilitation clinic." On the staff of the clinic would be a corps of medical advisers, psychometrists, clinical psychologists, medical and psychiatric social workers, training agents, and placement officers. It would be the function of these specialists, working singly and as conference boards, to make a complete investigation of each client's vocational possibilities. After a plan of service is formulated for each client, it will be the responsibility of the rehabilitation agent to guide the client through the successive steps until final placement in satisfactory employment.

Various specialized services must be established in each region. These may include schools to provide basic elementary education to veterans of limited education; special schools for training the blind, especially in making a satisfactory adjustment to his blindness in terms of his daily living; schools of lip reading and speech correction; try-out or opportunity schools for providing experience and elementary training in a variety of trades to men with no occupational background and with no vocational plans. There would be special facilities for training the convalescent tuberculous. For the more seriously handicapped there should be sheltered workshops to provide profitable employment in a protected environment.

In order to find employment for the veterans upon completion of training a staff of placement officers must be organized. Although the United States Employment Service maintains a special service for the placement of veterans, the supervision of the placement campaign must rest with the Rehabilitation Service. Theirs is the responsibility for seeing that the client registers and fully cooperates with the USES, that he plans and vigorously prosecutes an employment campaign. Twenty-two years of experience in the rehabilitation and placement of handicapped workers have demonstrated the utmost importance of using every possible "iron in the fire" in finding suitable employment for the handicapped.

VOCATIONAL GUIDANCE.—Perhaps the most vital part of a rehabilitation program for disabled ex-service men is the guidance, that is, the competence of the specialists who assist the men in choosing employment objectives. A serious shortcoming in the program after World War I was that too many clients were trained for objectives for which they had insufficient ability or scholastic background. An early report[1] of the first rehabilitation program reviews the men in a certain University School of Commerce to which only the higher type of men were assigned. Even of this selected group, the scholastic preparation embraced only a little over one year of high-school training. In this program, too, effective guidance for the disabled ex-service men will be one of the most difficult counseling jobs ever presented to specialists in this field. This is due primarily to the large number of problem cases, especially (1) those whose disabilities are such that they must make a decisive change in employment, (2) those who have insufficient education to enable them to select wisely, and (3) those who have not had definite vocational experience.

The vocational advisers must be specialists in the use of intelligence tests and physchometric methods generally. Even more important, they must be thoroughly familiar with job processes and environment, and must know the demands and possibilities of a wide range of jobs. They must be able to recommend types of training which will effectively prepare for specific employment.

SUPERVISION.—In vocational rehabilitation service, the term "supervision" has a double meaning: first, supervision of the client himself and, second, supervision of the training and other services provided to the client. Proper supervision of the client is vital to a successful program. It is a job requiring the full-time attention of many persons. Merely to inspire each trainee with sustained interest in his training can consume the greater part of the time of an agent in charge of the training programs of 40 or 50 trainees. To adjust training difficulties, change courses where necessary, and

[1] Federal Board for Vocational Education, *Annual Report, 1920.* Page 384.

exercise wise control in especially difficult cases is enough to tax the resources of even an experienced and capable supervisor every minute of the day.

Also, it is the responsibility of the supervisor to see that training agencies really train. It cannot be taken for granted that such is the case. This is particularly true of training given "on the job" in private business establishments. As a rule the proprietor or foreman is not skilled in teaching methods. Sometimes the training agency may deliberately sabotage the training schedule so that the period of tuition payments may be prolonged. Sometimes the trainee is denied the opportunity of learning new job processes so he may be kept at routine tasks. Even in reputable, established training institutions where there is no question of exploitation either of the trainee or of the Rehabilitation Service there is always the question of whether the trainee is profiting fully from the course. In this connection it must be remembered that many trainees are necessarily entered in commercial institutions, colleges and universities, and technical schools with less formal scholastic background than is required of regular students. In such cases, the supervisor must be constantly on watch to see that the ex-service man's greater maturity and greater purposefulness in working toward a specific employment objective more than offset the disadvantages of inadequate preparation.

Lessons From the First Soldier Program

Having listed some of the principles that should govern in setting up policies of organization and administration, it might be well to mention some pitfalls which, on the basis of the experience of the first soldier rehabilitation program should be avoided.

One of the major difficulties in the first program was the pressures, mostly political, to extend in individual cases types of training for which the men were not susceptible and types of benefits to which they were not believed eligible. The overruling of the decisions of administrators in order to give in to outside pressure was a disrupting

factor. Probably this is a factor which cannot be entirely avoided. It gives point, however, to the statement that the administration of the program of rehabilitation for ex-service men will be an exceedingly difficult task, which will call for administrative competence of the highest order.

Another difficult aspect of the program is that of the so-called "training pay," that is, the allowance for the maintenance of the veteran and his family during the training period. As the soldiers return from the war, a grateful Nation will want to grant to the disabled men a generous allowance which will permit them to pursue their studies without financial worry. This, however, can cause immense practical difficulties if the training allowance is higher than the wage or salary the trainee may reasonably expect to receive after the completion of preparation for his chosen employment objective. In the first soldier program some training programs were dragged out to inordinate lengths for this reason. Trainees drawing training pay of from $100 to $150 a month had little incentive to speed the completion of their courses if the jobs for which they were in training paid normally only $15 or $20 a week. It is essential to work out some kind of plan for the termination of training-pay allowances after a reasonable period, or at least reduce them to such levels that employment in private industry will be more profitable than remaining in training.

Another major pitfall to be avoided is the former practice of approving men with only a grammar-school education for courses normally requiring at least the equivalent of a high-school graduation as pre-requisite. The tremendous development of the vocational guidance movement, together with a similar phenomenal advance in the equipment and techniques for practical trade training, should do much to obviate this failing of the program.

In the last soldier program, and in the civilian program for the past 22 years, considerable emphasis has been placed on the necessity for "training into employment." The practice of providing training in establishments where the trainee would eventually be-

come an employee was developed because of the difficulty in securing employer acceptance of handicapped applicants. This is merely to say that training is not enough. A job must be secured. In a period of demobilization and economic dislocation, it may not be possible even for a trained placement agent to find jobs for disabled workers. It may be necessary for the Government to pass legislation inducing employers to accept disabled workers. It probably will be held incompatible with the "American System" to *force* employers to accept disabled workers. It is not unlikely, however, that the Government will make certain modifications in the workmen's compensation laws and the retirement and sickness-benefit laws which now make it so difficult for physically impaired workers to find employment.

INDUSTRIAL PARTICIPATION IN THE REHABILITATON OF THE WAR WOUNDED

By RUTHERFORD T. JOHNSTONE, M.D.
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Rehabilitation of our armed forces has been attempted following all previous wars but has never been successful. Nor is it likely that it will be successful after this one unless the vision of those charged with its fulfillment embraces more than a financial bonus or some paltry course in vocational training. Rehabilitation in the past, especially after World War I, failed because it attempted to segregate the wounded, to place them in institutions and surround them with barriers suggesting utter futility. In a world apart they toyed with beads, leather, wood, and other knickknacks, the usefulness of which must have been questioned by even the dullard among them.

Rehabilitation of our military body is interrelated with the problem of post-war reconstruction of the entire populace — not independent of it. It, too, will be affected by the socio-economic order. Only by taking full cognizance of this will any plan be successful. Consideration must also be given to more than just the aspects which interest the political economist or sociologist; it is necessary that a doctor of medicine prescribe.

The ultimate in progressive medicine is preventive medicine. Medicine anticipates that the immediate post-war period will not be devoid of confusion, physically, emotionally, or ideologically. But it also knows that much of this can be reduced to a minimum by the application of preventive measures while the war is still in progress. In the writer's opinion, the problem of rehabilitation entails the psychological care of our forces *before* they are demobilized. There exists no doubt that they are receiving good medical and surgical care for their physical ills or wounds while

in training or in battle. But what of their mental health, especially as it is likely to be affected by their contemplation of the future? It is with regard to this that the radio could offer a means of promoting mental health among our defenders either in America or elsewhere, yet it fails miserably in this respect.

The soldier, sailor, or marine stationed in some dangerous outpost has left behind him a wife or loved ones about whose economic security he is none too sure. In addition to the assault to his nervous system, born of a terrifying mechanized warfare, is the mental perturbation arising from speculation. He wonders during such hours why labor is striking; he questions if he will be able to resume his former occupation now held down by a woman; he shudders as he hears the pessimistic commentator tell him the world is headed straight to perdition. While his cerebral screen is recording a dismal picture of the future there reach his ears a myriad of radio programs which must sound asinine. Scattered among the songs, rhythm, and questionable humor, are the platitudes of some husky young announcer urging the fighting men to give the "old college try." Now the value of any radio program furnishing amusement to the armed forces is not to be denounced, but this is not enough to forestall a natural concern about the future. Neurosis is born of worry. Preventing this should be attempted before peace comes, for by so doing there will be fewer mentally ill to be rehabilitated. In no previous war has there existed such a medium of contact as the radio between our foreign forces and those in the homeland concerned with their future. It should be utilized to supply them with an optimistic aperitif, not to inebriate them with pessimistic forebodings.

At this time those in far-flung places should know that authorities who have studied America's needs and resources maintain there is no justification for the dour predictions occasionally voiced. They anticipate a post-war transmutation that will usher in an economy and standard of living designed to benefit a greater number than ever before. They point out that unlike World War I, demobilization will not be en masse, that a slower rate of demobilization will

permit a steady absorption of the armed forces into constructive fields of endeavor. Industry, instead of becoming idle, will redirect its activities toward supplying the people with those necessities and luxuries this war has denied them — automobiles, radios, typewriters, vacuum sweepers, tires, furniture, clothing, pots, pans, cosmetics, ad infinitum. It is estimated that before 1950, sixteen million homes or units ought to be built to care for the increase in families or to replace the present substandard structures. Processing and distribution of food will demand millions of workers not previously engaged in such an endeavor. Approximately forty-five million men, women, and children in America were inadequately nourished at the outset of this war. This will not happen again. Likewise, the rest of the world will look to us for a greater part of their food supply. Space prevents enumeration of many other new or enlarged peace-time activities, such as foreign and domestic commercial air commerce, health extension, education, and the like. In such lies our hope — the same that has pioneered this country since its birth.

Equally important in the proposed plans for rehabilitation is another measure which should be sponsored by industry at this time. Although in essence it would be a business transaction, its present influence would fulfill a requisite of preventive medicine. We on the home front are certain that those under contract to defend this country will not default that trust. While they are still in service, cannot we promise them more than a pusillanimous placebo of a pension or a bonus, which are actually only condolences? Cannot we proffer them a promissory note of assurance that they will be utilized equally with those at home in the post-war reconstruction? Such a suggestion is practical since the machinery exists to carry it out. Through the National Association of Manufacturers, the National Chamber of Commerce, and allied state, county, and city chambers of commerce, all types of industry, manufacturing, mining, milling, agriculture and such, could be contacted to secure a promise that men previously in their service would be returned to their jobs. Such a contract could then be mailed to the man now

in service to whom it applied. Only in a small percentage of cases will post-war circumstances nullify the contract. The reception of such a bond of faith would create a morale among our armed forces certain to withstand the influences leading to neuroses, malingering, or other forms of unstable mental health.

Also, *before* peace comes, industry must *prepare itself* for its full participation in rehabilitation. It will be disastrous if management postpones plans for utilization of the returning soldier, wounded or otherwise, until the last bomb is dropped. Unquestionably even now industrial leaders are anticipating the trends business will follow after this international inferno has been quenched. Among the pages of this business "bible" garnered from Babson and other experts, must be inserted new material for study, not dealing with markets or money but with human beings. *Now* is the time for employers, managers, and personnel directors to plan a post-war program. Material to guide them in this should be supplied by the government and socio-economic agencies allied with the government in preparing for the reconstruction.

In the job that is to be done for our returning wounded, it is essential that industry discard its pre-war concept of disability. Too long has it cast aside those with slight physical defects. A wasteful nation has heretofore piled high a scrap heap of materials and men. For the war we have reclaimed wasted rubber, tin, and iron. For the peace we must salvage manpower. For war production management has been forced to accept the physically handicapped or the elderly workman. To utilize these, selection of the job to suit the applicant has been practiced, a prophetic policy when analyzed. It signifies the post-war adoption of placement examinations and the abandonment of the rigid, arbitrary pre-employment examination — a stupid system which rarely evaluates the applicant's capabilities and denies work to the willing.

However, before industry can be asked to accept the war wounded or the physically handicapped, a legal determent found in the Workmen's Compensation Act must be removed. In most states the benefits of this act have been gradually extended to include disabilities

other than those resulting from direct trauma, i.e., the occupational ills caused by solvents, gases, metals, or dusts. Such an extension is obviously right and just. But in addition there exists a strong tendency to award compensation to claimants who allege that their occupation has caused or aggravated a disease which medical science knows to be of communal origin. It is not uncommon to have an Industrial Accident Referee, or court, consider some almost effortless activity to have caused a coronary thrombosis, ruptured gastric ulcer, cerebral hemorrhage (stroke), or other pathological condition always held previously to be unrelated to occupation. Admitting that this practice is a beneficient attitude, it imposes an unwarranted burden upon industry; it renders Workmen's Compensation a form of health insurance, a mistake not foreseen by the original designers of the Act. It is apparent that the employer, especially of a small group of workmen, will be hesitant about accepting (rehabilitating) a soldier with impaired limbs, heart, or lungs if the law subsequently will hold him responsible for the victim's breakdown in health. This conflict has existed with the veterans of the last war too often for their comfort. Industry must be assured that a disability occurring in a rehabilitated soldier and due to his war injury is to be charged to the government, not to the employer. If this is done, cooperation of industry, large and small, will be gained.

In a previous paragraph it was intimated that following the last war the disabled veteran was subjected to a meager, limited training usually lacking in practical value. In rare instances some received a college education fitting them for professional careers. Undoubtedly such an opportunity will be offered in even greater proportions and facilities to the returning veterans of this war, a discussion of which has been assigned to other contributors to this symposium. But for those whose past training and ability fit them only for pursuing a living with their physical powers, it is imperative that their education be conducted *within* the walls of industry. One doesn't learn to swim by going through the motions on the living room rug. Nor will one learn a new trade, a useful occupation, from some vocational teacher or physiotherapist in a soldiers' home. We now

appreciate that there is no limitation to what can be taught within our industrial plants and that the student learns better by being placed within the atmosphere of actual production. The jest that grandma gave up her knitting to become a welder at Lockheed significantly indicates that there are no limitations to the possibilities industrial rehabilitation can offer.

Finally, industry cannot successfully rehabilitate our military forces unless it employs an adequate program of industrial health. There was a time when industrial medicine limited itself to dabbing iodine on cuts, smearing ointment on burns, or setting fractures. Today this type of medicine prevents injuries, protects the workman from the effects of noxious gases, fumes, or solvents, and provides a degree of sanitation within the plant that often exceeds that found in the workman's home. Unfortunately, such a program exists only in our large industries, the majority of our smaller plants being devoid of any type of medical care. But after the war this deficiency must be rectified since obviously all of the returning military force cannot be placed in the larger industries.

For some years it has been contended that medical care has not been extended to those who need it most. Despite the claims of organized medicine that medical care can be had by all who seek it, and regardless of where the fault lies, there remains a class of people of considerable proportion who fail to be benefited by a medical service. The majority of these are employed by industry. Yet to supply the workman medical care only within the plant does not answer his family health problem. Medicine is now a complex procedure combining the physician with expensive apparatus and multiple facilities. The needs of our people have exceeded the resources of a single physician; they require a family health center. No organization can be better utilized to fulfill this necessity than industrial medicine. No other phase of medicine is so intimately related to the socio-economic problems confronting this nation, for it is the industrial physician who deals with the very group of people for whom some type of health insurance is being urged.

In the future, industrial medicine will not confine its activities to

the prevention of accidents or occupational diseases. It will promote individual physical and mental hygiene, institute nutritional guidance, sustain athletic endeavors, prescribe periods of rest, and aid management in selecting the proper employee for each specific assignment. The plant physician and his nurse will not be resorted to only for treatment of an ailment, but will become the workman's confidant and counselor. Medical service will be extended into the home where the supervision of diets, dental hygiene, sanitation, and prophylactic measures against disease will be introduced. By means of the placement examination and periodic re-examinations of all employees, physical defects will be corrected and tuberculosis, cancer, and heart disease will be reduced to a minimum. Into such an environment our veterans can return to pursue their peacetime occupations. It promises them a part in the future happiness for which they are fighting. Truly, in modern industry resides the machinery and possibilities for the successful rehabilitation of our nation's defenders.

VOCATIONAL REHABILITATION OF THE DEAF AND HARD-OF-HEARING EX-SERVICEMAN

By C. G. BLUETT
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A blind man has written the best story about the self rehabilitation of a deaf[a] man I have ever read. It is the story of a Mr. Carter, a veteran of World War I and the Battle of the Marne, at Chateau Thierry Belleau Wood and Hill 204.[1]

The whole world exploded about him which eventually resulted in the loss of his leg, but this was insignificant in his mind to the loss of his hearing which resulted from the same explosion. It was the loss of his hearing which caused him to query in agony of soul; "Why? Why must this happen? My whole life shattered. My future gone."

Other men and other veterans have felt the desolation this man felt when they believed they no longer could converse with their fellowmen or enjoy the great benefits of hearing, the normally hearing take so much for granted. It, however, is not the frustration this man felt that is of permanent interest. It is the subtle transformation of the man from an agonizing, beaten person, troubled with feelings of inferiority into a confident, successful business man.

The transformation began with the inspiration received from a great woman; it continued through the intelligent, persistant study and practice of lip-reading; it was crystallized by the loving insight of another woman who forced him to depend upon himself, and

[a] Carter was adventitiously deaf. He had lost all usable hearing. His psychology is not to be confused with the congenitally deaf, or those who lose their hearing before speech is developed and must, therefore, learn speech, by artificial means. He had memory for sound patterns acquired while he had normal hearing, and could have interpreted speech if he could have heard amplified speech sounds. The hard of hearing are able to hear and interpret amplified speech sounds.

became assured as he experienced the thrill of one small achievement after another.

The response the handicapped man makes to small influences in his life determines the difference between success and failure. The achievement of the great inspires one man to do likewise, in another, the same achievements only increase his feelings of inferiority. The determination to study an art or a skill that will help to overcome the handicap, with some soon fades. Instead of carrying on, they begin to present reasons why it can not be done, reasons why the system is wrong. The attempts of others interested in their welfare to cause them to try their wings is misinterpreted. They resent the inference that they can do more. Finally they prove to themselves that they can not achieve because the lost opportunities for preparation leave them unprepared when little periods of test arrive. The cumulative habit of failure and escape becomes indelibly impressed upon them.

The man whose intense feeling, vivid imagination and enthusiastic energy when properly directed enables him to achieve better than average success is the same man who under different circumstances may become a cantankerous, embittered and unproductive person. He may continually dramatize himself and his situation, criticize those whose duty and wish it is to help him and reject opportunities that might be his if his thinking were less emotional and biased.

Psychology of the Deaf, and the Hard of Hearing

A great deal has been written and said about the psychology of the hard of hearing, and deaf. Pitner and Associates[2] studied the personalities of deaf, and hard-of-hearing adults by means of personality tests, and found both groups a little more neurotic, introverted and less dominant than the normally hearing. Wells[3] too, using the Bernrueter Personality Inventory, found a group of hard of hearing more emotional, introverted and less dominant than the average of a comparable normally hearing group. From his preliminary study Wells learned that the hard of hearing generally

agree that there is a real difference between themselves and the hearing world but as to the extent, there are widely diverging views ranging from a peculiar, or unique psychology, to that of a slight variation from the normal.

On the whole the literature on this subject is not convincing. Wells[3] found that when he compared a group of hard-of-hearing men and women who had successfully surmounted their handicaps with a paired group of their hearing friends no significant personality differences were apparent. Knowing a number of those persons included in the study, I would not say their personalities did not differ, but rather that they are mature people who have confidence in themselves and discount their feelings, retaining distinct personalities.

If by psychology of the hard of hearing, or deaf we refer to temperament or attitude then there are no two exactly alike. The element that is probably common to unadjusted physically handicapped is the lowering of control, but the expression of temperament is a pattern of its own. This may be demonstrated on the Humm-Wadsworth Temperament scale[4] which is very broad in its scope.

Of sixty-six physically handicapped persons who were administered the Scale, fifty of the clients or 75 per cent indicated that their control of their emotions was below "usual." In continuing to use this scale the same phenomena continues to be apparent among those who apply for vocational rehabilitation. The patterns of the temperaments, however, are as varied as among the control groups on which the test was standardized. This is true also of the hard-of-hearing, and deaf members of the group who were given separate study.

An individual in the group might indicate that he responded to the difficulties of his handicap in a pugnacious, suspicious and hard headed manner; others that they responded in a matter of fact, plodding, methodical groping for an inspired goal; or with selfish, cynical, shrewd, anti-social, even criminal methods; or in over

talkative high-handed over active way, possibly coupled with periods of depression, listlessness and apathy, or shyness, reserve, seclusion and day dreaming; or any combination of these; yet these attitudes were heightened by the common element of poor control.

On the other hand even among these vocationally unadjusted clients at least 25 per cent had adequate control and a few were over controlled. The only prevalence of the temperament pattern is in direct relation to the degree that the Manic-Depressive Temperament is prevalent in the general population. A hearing handicap then would tend to heighten or conflict with a pre-disposition of this kind which is distributed among the hard of hearing, and deaf, in the same proportion as among the so-called normal population.

Among the unadjusted are some who undoubtedly would benefit by psychiatric therapy. The deaf are more likely to accept their situations as inevitable and to be less subject to strain than the hard of hearing who are so often on the border-line. They can when they are not expected to, and can't when they are expected to.

The strain of trying to maintain consistent performance is conducive to bluffing and consequent feelings of guilt. Ordinarily the hard of hearing do not seek far beyond their hearing for reason for their difficulties, but it would be an interesting experiment to determine to what extent psychiatric therapy might uncover vague motives the discovery of which would help them to grapple with themselves.

Changed Circumstances Aid Veterans of World War II

The days when the hard of hearing, or even the deaf should feel that they are "buried alive" is as unnecessary as an old fashioned cuspidor at a night club, though some of the patrons might use it becomingly were it provided. In 1918 when the veterans of World War I were returning, hearing aids were practically unknown in the United States except for speaking tubes and horns; the great educational campaign of the American Society for Hard of Hearing[b]

[b] American Society for Hard of Hearing, 1537 N. W. 35th St., Washington, D. C.

had not begun except among isolated groups in separate cities and lip-reading had not been incorporated in the free, public, adult education programs of the larger municipal school systems. For that matter vocational rehabilitation itself was but beginning in this country as an experiment.

The number and percentage of veterans of World War II who must face a hearing handicap will be greater than for previous wars. The air service in particular generates this kind of disability and this service is being continually expanded. The continuous pounding of the sensitive ear mechanism by repercussions of big guns and even diseases caused by foreign climates will effect the hearing of large numbers of the greatest armed forces we have ever assembled.

However these men face a vastly different situation from that of 1918. Some advances have been made in the medical field itself so that some of those whose injuries or illnesses have resulted in deficient hearing may realize relief or escape from this difficulty. The campaign of education conducted by the American Society for the Hard of Hearing has caused the public to be much more considerate, understanding and helpful toward these individuals. As a result of the campaign of these organizations, hearing aids have been established in many churches, theaters and places of public gatherings. These organizations provide social and educational activities as well as constructive work for all who wish to participate. The vocational rehabilitation services have gained a great deal of experience in the period between two wars and now propose to expand this program so as to make available a complete service to the hard of hearing, or deaf ex-serviceman.

These services may begin at any time the Vocational Rehabilitation Representative (here after referred to as the V. R. R.) and the hard of hearing, or deaf veteran are brought together. The V. R. R. must obtain an intimate picture of all the inter-relationships of the handicapped veteran's problems so that he may secure the cooperation of all agencies that contribute to the final purpose of adjusting him to civil life. From the Veteran's Administration advice

will be received regarding the extent of the hearing loss, whether it is progressive, whether further treatment or operation is indicated and suggestions as to the kind of environment that might aggravate the condition. This agency, too, will supply the veteran with a hearing aid, if practical, and with compensation or maintenance, if he is eligible. The American Red Cross will assist the veteran with domestic, social and economic problems. These services are pertinent to the final preparation.

Lip Reading and Related Skills Basic Requirement

As a part of the complete program, lip-reading is basic. This training may be given to advantage before the veteran leaves the medical center in the United States. Such a program was conducted at Cape May, New Jersey,[c] following World War I, with beneficial results.[5]

During the early days there was not much confidence in the experiment. The men felt they were being unnecessarily delayed. They had come from the occupations of farmers, laborers, clerks, machinists, electricians, chauffeurs, and miscellaneous occupations. They did not believe they could return to these occupations. According to Dr. Berry, some of them looked forward only to a pension and dependency. The study of a foolish subject, lip-reading, was non-essential and the difficulty of it made some of them break down and cry before their patient teachers.

Some of the best products of the school were of least education — the star of them all being an illiterate negro who grew so adept he could repeat words and sentences of a foreign language though he had no conception of their meanings. Before the school was closed enthusiasm ran high and there are many stories of the success of its graduates.

These men devoted three full periods per day of 45 minutes each to the study of lip-reading, for an average time of 2.7 months. Such intensive study has a therapeutic value, improves morale and provides encouragement for any future activity as well as a bulwark

[c] Later transferred to Fox Hills, Staten Island, N. Y.

against progressive hearing loss at a time when it is most needed. Men who otherwise might defer such training are introduced to its advantages in spite of themselves. The intensive nature of the training is of greater value than short periods in public evening school or even in private lessons, between which, intervene the many activities and conflicting interests of adjustment to civil life. These men drawn together by several years of common experience competing with each other for mastery of the new language are relieved of the embarrassment that attends entering a public school class among strange persons from many walks of life. Having been drilled sufficiently to acquire some facility, practice is automatic. The regulated drill of public school class, or private instruction, will then be less difficult to encompass and should provide valuable follow-up practice.

Voice training should accompany lip-reading instruction both as a separate study and in the lip-reading class. Such a method recognizes the use of voice in the lip-reading class rather than voiceless instruction that is sometimes advocated. The atmosphere of the class room is thus made to comply with life situations, hearing aids are used by those who are benefited by them and every one takes advantage of as much hearing as he can muster. Stress should be laid upon articulation and pronunciation. It is important to make other persons understand the speaker and thereby avoid drawing attention to his own handicap of poor hearing. Poor articulation and voice control often accompany a severe loss of hearing.

Films for the teaching of lip-reading were first developed by Dr. Marie Mason, of Ohio State University, who is continuing with her research in this regard, under the direction of Dr. G. Oscar Russell, of the Speech Department of the University.[12]

The University of Southern California has developed the Audio-Visual-Kinesthetic approach using dramatized material from life situations, in films. Dr. Boris V. Morkovin had previously used similar methods in the teaching of foreign language. Under his direction Mrs. Lucelia Moore and Miss Ruth Bartlett applied the

method to the teaching of lip-reading. As a further development, the University of Southern California is producing occupational Speech-reading films such as welding, lathing, etc., for which a source book is being prepared.[d]

Vocabulary and lesson material is automatically introduced to the class situation by means of film material and it is claimed that students acquire facility in interpreting speech movements, more readily, than when other methods are used alone. A great deal of down-right fun may be visualized and actually does occur, when learning is spontaneous and natural. This greatly offsets the otherwise forbidding aspects of deficient hearing.

Re-education of Hearing

Kennedy and Browne[6] have experimented since 1928 with the re-education of hearing and have had considerable success with the Phipps unit. This amplifying device eliminates the usual diaphragm which transmits many extraneous noises. Instead of a diaphragm, a tone arm is attached to a vibrating armature which in turn is mounted in rubber. Instead of sound being forced through the ear canal and the middle ear, the tone arm is applied directly to the bones of the head, which act as a conductor of sound to the nerve receptors in the inner ear. Great amplification of sound may thus be accommodated without pain being experienced and as a consequence the dormant hearing mechanism of severely hard-of-hearing persons, even some who have been considered deaf, is stimulated and re-educated.

The Hearing Clinic at the University of Southern California has been using this kind of amplifier to advantage, with severely hard-of-hearing persons. This device might be used to encourage returning soldiers, for whom the usual amplifiers using a diaphragm, do not function satisfactorily. As a result they should be more receptive to the possibilities of the electric, vacuum tube, portable hearing-aids.

[d] From a letter from Mrs. Lucelia Moore, November 1942.

Hearing-Aids for All

Persons with as much as 80 to 90 decibels of hearing loss in both ears may benefit by the portable aids, and should be fitted immediately. Their constant use improves reception. Even though, only deep vowel sounds are heard, the use of a hearing-aid should not be dispensed with. It is helpful for an individual to be aware that another is beginning to speak without requiring that person to touch him, to call his attention. Certain intonations and voice inflections may be recognized even though all cycles are not heard, and even more important it is the deep vowel sounds that are the most difficult to see on the lips. If the eye catches the consonants that are pronounced in the front of the mouth while the ear hears the vowel sounds formed in the throat, the combination may be assimilated into a connected whole more readily than by lip-reading alone.

Even the faintest sound has an orientation value. I have observed consistent earphone users who unconsciously reach for their ear tip, insert it in their ear and flip the key to "on" when they are not engaged in conversation at all, but giving close attention to some scene in the street, or even a good work of art. Somehow they are unconsciously aware of an extra portion of their senses that may be added to increase their reception. They may possess but four and one-eighth senses, but they are not content with four alone.

Selecting a Hearing-Aid

As to the selection of a hearing-aid, the medical services of the United States Veteran's Administration are prepared to supervise this procedure for veterans for whom it authorizes the purchase of hearing-aids. The V.R.R. is trained to assist his clients with their choice of instruments.

The audiometric chart from which a curve of best fit may be plotted is of assistance in determining whether an air or bone conduction instrument is advisable and to indicate the relative amplification required for each cycle in the speech range. An Otologist, or a trained audiometrician may thus provide valuable evidence as to the kind of hearing-aid the client requires.

The hearing-aid manufacturer strives to provide an instrument that will give maximum amplification in the cycles in which the greatest loss occurs as indicated by the audiometric chart without distorting the over-all performance. When the loss is uniform or consistently within the high or low ranges, reasonable accuracy is achieved, but when the pattern is complicated, only the laboratory can build up the selective amplification required. It is not yet possible to duplicate the possibilities of the laboratory within the compact design of the portable aid,[8] but the efforts of the manufacturers to do this are not to be disparaged. Great gains have been made.

The work of fitting the aid is a job for a technician who thoroughly understands the principles of amplification of sound, as well as the hearing mechanism, for he then knows the limitations of his instrument as well as its possibilities. Hearing-aid manufacturers might well give more attention to the training of technicians for the field. It is the well trained technician who wins the confidence and loyalty of hearing-aid users.

It is confusing to "shop" around among hearing-aids, but is the only practical method at present. When one or more instruments have been tentatively selected the wearer may compare them under varying conditions if he is allowed to take them from the agencies. There is well justified resistance to this practice, but until some other equally valid method is arranged, the wearer is justified in insisting upon this privilege.

The best test of efficiency of the instrument, though not always most convincing to the wearer, is that of using word and sentence tests emphasizing various combinations of sounds that may be objectively evaluated. The Bell Telephone Laboratories have provided several lists of sentences from which a test may be devised.[7] Watson, Knudsen and Watson[8] have devised a very practical and easily administered list of consonant words and vowel words with a method of exact scoring for each instrument tested. These tests are far superior to the usual "Do you hear me now" queries of

interested parties. Particulars for administering them are provided in the indicated references.

Vocational Training Should Be Carefully Considered

To the extent that a hearing-aid overcomes the hearing loss, to that extent the disability is mitigated or eliminated. For some ex-servicemen, the hearing-aid may seem to be the only service needed, but in view of the progressive tendency of most forms of pathology of the ear, particularly with increasing age, sound rehabilitation practice recommends that all the above services be made available and urged upon those, even with moderate hearing loss. Furthermore the advisability of vocational training should be carefully considered in each instance.

Whether or not vocational training is required depends upon the attitude of the disabled veteran toward his previous occupation, the permanency and availability of the employment, his capacity for that kind of work and the possibilities for his advancement. Even though not physically handicapped many men were maladjusted in their occupations prior to entering the armed services. The handicap of poor hearing may only increase, rather than create the maladjustment.

It is not enough that the disabled veteran is able to return to an occupation which provides no stimulus, opportunity, or security. Approximately 70 per cent of hard-of-hearing, and deaf persons surveyed in 1935[9] according to their employers had no opportunity to advance with the firm by whom they were employed.

Work History Important

Tracing the work history is one of the most direct and effective methods of obtaining an insight into the attitude, inclinations and personal history of the client. Episodes and incidents that give rich flavor to the man's story come to light as the work history from the days of leaving school, is traced. Just how did he obtain his first job? Why did he leave that job? What was the next job? How long did he work there? Just what did he do? This type of questioning

may bring to light the influence of friends or relatives, unexpected ties, prejudices, fears, qualifications and aptitudes. Periods of illness, or mentions of accident, may bring out secondary disabilities not hitherto mentioned His social and economic level is thus indicated and often the disparity between his stated objectives and his unconscious but real belief in himself, is indicated.

But the work history and related data can not always be relied upon to indicate what the man should do in the future. The V.R.R. takes the personal history for what it is worth; then sets about getting a cross section picture of the man he is today. If he can suggest an occupation that will boost the client to a level of which he is capable but has not had opportunity to reach, he is benefitting not only the man but society at large by increasing the man's skill or information; if on the other hand he finds that part of the client's trouble has been "overshooting" he should suggest objectives that are congenial but eliminate the strain of poor adaptation. An example of the first order might be that of training a former clerk in accounting; the reverse would be locating as stock clerk a man who attended business college and has studied accounting but has never been able to hold a permanent job at that level.

Objective Measurements Should Be Used

Probably the quickest and most satisfactory method of obtaining an impartial estimate of the client's current capacities is by means of objective measurements. There should be nothing didactic about this for our present instruments of measurement are by no means infallible.

A wide battery of tests giving corroborative evidence together with personal history and subjective estimate obtained from interview should be well considered in relation to each other as the basis of judgment. Nevertheless the tests have their place and there is no special problem in selecting such tests for the hard-of-hearing, or adventitiously deaf person. With a little ingenuity even those tests that are not self administering but require verbal instructions, may be adapted.

It is possible with our present test materials, even with some of our group tests, to derive a pattern of sub-tests that yield information regarding the individual's general intelligence and specific factors which may require special consideration. From experience we may have developed considerable skill in interpreting the patterns these measurements present. In most instances we are able to give sound advice to the client regarding the occupation that he would most likely find adapted to himself, particularly when the mental and aptitude tests are supplemented by interest inventories and temperament analysis.

Nevertheless there is a great need for the data with which to synthesize, that is, information concerning what the measurements mean in terms of job adjustment. This is information we hope the present personnel work of World War II will provide. Regardless of the fact that the occupations now being studied in terms of test scores are military occupations, the majority of these (in terms of the distribution of jobs, not in terms of numbers of men) are also peace time occupations. The data should, therefore, go far toward solving our problem in this regard. This experience too should refine our methods of analysis. It is to be hoped this information will be made available for Vocational rehabilitation purposes.

Considerations Regarding Training Facilities

When the personal history of the hard-of-hearing, or deaf veteran has been obtained, his personal and physical problems have been given attention and the objective analysis is completed, the client and the V.R.R. may begin the discussion of the objective, training, and placement opportunities.

There are so many opportunities open to the man with high school diploma, Junior College Certificate or University degree, that are not available to the man with equal capacity who does not possess a signed paper to certify to it, that every person who can do so should take his training in the public schools and work toward graduation from one of these units. However this procedure requires more time than a strictly vocational course in private schools that

metaphorically drive a wedge rather than move the whole front toward the objective. Moreover the adult hard-of-hearing, or deaf person has much difficulty under class room conditions using the usual lecture, or question and answer method. So far, there has been no noticeable tendency at the Junior College or University level to provide special facilities to solve this problem. Even in strictly vocational schools the work is laid out in courses covering a semester or quarter and prior to the present Defense training, school officials often displayed apathy, even antagonism, toward breaking up such courses into units or blocks that could be completed in shorter time.

As a result of these conditions vocational rehabilitation services in the past have relied greatly upon private schools, tutors, correspondence courses, and apprenticeship, or "on the job" training. Federal and State funds are provided for this purpose.

We do not know at this time just what facilities will be provided for war service casualties, but even with national training centers only the more popular kinds of training could reasonably be provided. The careful, individual selection of objectives makes it impractical to provide training for all of the wide variety of occupations from accountant to zymurgist that may be requested. For this reason a thorough survey of public and private facilities already existing and their careful utilization may prove the more efficient method.

Wide Variety of Employment Objectives Available

An equally wide variety of occupations is open to the hard of hearing and adventitiously deaf. There can be no matching of degree of hearing loss and jobs, for the degree of handicap is entirely relative to all other factors. One who works with hard-of-hearing and deaf unadjusted persons may begin to feel that there are limitations. Then suddenly he comes upon a severely hard-of-hearing, or deaf person carrying out the duties of what might be considered an impossible job. Probably the man is doing it entirely unconscious of the fact he is not supposed to be able .

The unusual instances are generally surrounded by extenuating circumstance. The most common being that of evolution. That is, the man lost his hearing after he had established himself, or he has a financial interest in the business, or he has an unusual degree of ingenuity. Ordinarily, the deafened individual beginning again must look for work in which hearing is not essential. The problem must be given common sense consideration. It is important to search for an occupation adapted to the man's aptitudes; then to determine the job within that field of work which minimizes the requirements of hearing. Engineering for example, offers drafting as the beginning job; medicine, with pathology as the objective; law, education, or sociology with special preparation in research methods for later use; economics with accounting, or statistics as the working tool. Writing for profit, or art, offer no obstacle. In the field of mechanics it is the environment that must be chosen, to avoid physical hazards. The work itself is not in conflict with hearing. These occupations in which skill is the major factor are compatible to the hard of hearing, or deaf.

For a man who is primarily a "front," a personal contact man; one whose mind does not accommodate itself to detail, there is no real solution. It is this man for whom a hearing loss is the greatest problem. When the conversation and repartee so essential to comaraderie must depend upon the pip-squeek of a hearing aid or fickle forms of another's speech movements, smoothness and casualness is lost. For this man a business of his own is probably the best answer. The fortitude and courage born of lack of forsight may stimulate others to do his detail work. Fortunately for these people, they often make the best lip-readers and are the most free from the grubworm of worry.

Placement Problems

When the objective is finally determined upon, and when personal and training problems have been solved, placement must still be effected. The ease with which the deaf, or hard of hearing may be placed is in direct relation to the demand for workers in general.

When the demand is strong they are easily placed, when there is little demand, their difficulties in finding employment increase. Given a choice of two workers of equal ability one of whom is not handicapped by poor hearing the employer will probably choose the non-handicapped man, in preference to the handicapped man. This is as true of the appointing official in civil service as of the private employer. The private employer, however, may believe, or at least offer as a reason for non-employment of a handicapped person, that the industrial accident insurance policy which protects him does not permit him to employ the handicapped man. Over forty per cent of employers insured with private insurance companies who were asked the specific question, "Are there any provisions in your insurance plan that make it impossible, undesirable, or impractical to employ the physically handicapped," replied in the affirmative.[10]

In the same survey employers were asked to indicate what disabilities would be rejected, flatly, as a policy, regardless of the applicant's other qualifications. Total deafness was rejected in 89.3 per cent of replies but the hard of hearing with 50 per cent loss and wearing an earphone, in only 32 per cent of replies. Compared to these percentages total blindness was rejected in 99 per cent of replies, cardiacs 45.6 per cent and asthma 38.8 per cent.

The deaf, in particular have had a serious problem in seeking employment in years of low labor demand; a hard-of-hearing person who could hear with an earphone had a much less serious problem, yet he faced discrimination.

The situation is different at the time of this writing, late in 1942. The hard of hearing have no problem at all in securing employment and for certain kinds of work, largely manual, even the congenitally deaf are at a premium. A congenitally deaf welder was placed in a shipyard this morning that as late as three months ago absolutely refused to consider a deaf employee. A severely hard-of-hearing girl whose earphone benefits her but little was placed as a mimeograph operator with the Federal Civil Service within the last few days. She has had nothing but temporary work at low pay level for years.

She is reported to be doing entirely satisfactory work. A hard-of-hearing man has become a machine shop foreman, who eighteen months ago was considered an insurance liability. These facts indicate the difference between feasibility and prejudice.

Needed Legislation

A study of industrial accident insurance policies reveals no specific stipulations against the hiring of physically handicapped persons. If the employer believes his insurance policy prevents it he may be influenced not by the policy but by personal advice of the insurance agency which may feel that a physical handicap increases the rate of accidents thus in turn affecting the rate of insurance. This would be true if the handicapped such as the hard of hearing, or deaf are employed indiscriminately at work for which they are not adapted, but it is not true when they are properly placed. It is an economical and social evil that a deaf, or hard-of-hearing person should be denied employment because of a supposition which, whenever taken to task, is disproved. When and if another period of low demand for labor is experienced some form of national insurance to which the handicapped may subscribe to protect themselves, should be instituted. This would relieve the private insurance companies of their responsibility for the handicapped. In a few states, there are already in operation Second Injury Funds, derived from unclaimed compensation awards, from which is paid the difference between the total disability and what the award would have been if only the second injury was compensated. This does not solve the problem, but is helpful.

Methods of Seeking Employment

The V.R.R. will direct the employment search of the deaf, or hard-of-hearing ex-service man, using all available agencies;[e] the United States Employment Service, the school in which he is trained, or by personal contact with employers. Over a period of years the V.R.R. acquires an antimate knowledge of the channels of place-

[e] Legislation is now contemplated which would cause all placements to be effected through the U. S. Employment Service.

ment for the handicapped. He is often able to effect placement by means of emphasizing the trainee's qualifications, even in organizations that would reject the same man should he apply at the front office. He may place the trainee with an organization only to gain experience before he makes application for a better job with another organization. He may attempt a direct mail campaign or instruct the trainee in these methods. He may work through friends of the trainee or friends of his own. Eventually the well trained handicapped man is placed, even in times of least demand, if he is willing to do his part. That part consists of not much more than making a consistent effort.

Summary

Vocational rehabilitation of the deaf, or hard-of-hearing ex-serviceman consists of securing the maximum benefits of medical treatment; the intensive study of lip-reading, voice and speech control, and re-training of residual hearing; the fitting of a hearing-aid; careful study of the factors in the case history, objective analysis, sympathetic interviews and experienced synthesis of a well planned vocational training program; it includes careful selection of the training agency and close supervision of the training, adjustment of social economic or personal problems during the period of training and finally assistance in securing employment, and follow-up to determine the effectiveness of the entire program. The deaf, or hard-of-hearing ex-serviceman, who can and will follow out this program to its conclusion is assured of adjustment to civil life. It is a program that is adapted to all, regardless of native ability, previous education, or work experience. The man who can not follow the program because of emotional instability may require years of special treatment and may never accept a sufficiently mature outlook on life to become rehabilitated. Others may wilfully abandon the program because of ulterior motives. However we may confidently predict success with the vast majority of returning soldiers, regardless of the degree of their hearing losses.

Throughout this paper we have had in mind the WAAC and

WAVE, the SPAR and Marine. Everything that we have said applies equally to these soldiers and to nurses.

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EMPLOYMENT OF EPILEPTICS

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At all times but especially during times of war, the intelligent and effective use of available man and woman power is of major importance. In the last war, epilepsy caused the rejection of 0.515 per cent of the men who came before the draft boards in the United States,[1] and of 0.186 per cent of enlisted men,[2] a total of 0.7 per cent. This percentage, when projected on approximately 50 million persons who are gainfully employed represents an army of approximately 350,000 epileptics who potentially are productive workers. As we shall see, many of these, possibly one-third or one-fourth are unemployable. What use is being made, or can be made of the, say 250,000 persons who are mentally and physically able, but are subject to seizures?

Consider first the armed forces. No epileptic no matter how able-bodied and intelligent, is accepted for service. In the last war the medical department of the United States Army reported "The patriotism of epileptics was a matter of common remark and they were inclined to conceal their defects."[2] After being accepted more than 6,000 were discharged when their condition was exposed. Rejection is complete and final, and the classification of 4-F, which the draftee receives, serves to prevent his employment in industry "If the army doctors say his physical condition is hopeless," argues the employer, "I can't use him." The employers and possibly the armed forces fail to realize that a man with a history of seizures who could not be placed on the firing line or in charge of moving machinery might be extremely useful in a score of other positions. Presumably also the government hesitates to employ a person who might become a life-time pensioner if incapacitated because of his seizures. The blame for this condition rests on legislators who have granted compensation to veterans for disabilities not related

to war services. Geneticists criticise the policy of excluding epileptics from the armed services on very different grounds, the folly from the biological point of view of exposing to death only the physically best of the nation's manhood. War enlarges the economic problem of epilepsy because it adds to both the relative and absolute numbers of the affected. Present patients are shielded from war dangers and from 5 to 15 per cent of the brain-wounded soldiers will become epileptics.

The reasons for keeping epileptics out of the armed services are understandable, but should they be barred from industry? In pleading for a greater utilization of handicapped workers, the head of the War Manpower Commission, Paul V. McNutt, declared "Workers must not be rejected for what they lack; they must be hired for what they have."[3] The objections of employers to hiring an epileptic are of two sorts. First, and probably most influential, are current misconceptions about epilepsy. Many persons suppose that epileptics are defective in body, mind, and in personality. Fellow employees have an unreasoning fear of a convulsive seizure and wish to see nothing so unpleasant. This attitude may be changed only by the diffusion of modern knowledge about seizures and by a general hardening of public morale. The horrors of war make a seizure seem unimportant. Employers may rationalize their unwillingness to hire epileptics by suggesting that the stress of hard work is harmful to the person subject to seizures, a conception fostered by misguided medical opinion which overemphasizes the value of a stagnant existence. As a matter of fact, attacks are most likely to occur when the patient is idle or asleep and in the majority of patients, activity of brain and muscle is an important antagonist of seizures. In England, bombing in the vicinity of institutions for epileptics did not increase the frequency of the patients' seizures.[4] Again, employers, like the general public, are unaware of recent advances in the diagnosis and treatment of persons subject to seizures, and share a general belief that epilepsy is incurable.

A second reason for refusing to employ epileptics is a law which

makes the employer liable for injuries which employees may sustain while at work. Recently, the Laymen's League Against Epilepsy asked officials of the various states to explain the standing of epileptic workmen under their compensation laws. Replies were received from 38 states. In only four of these states does the labor code specifically mention epilepsy. In only 9 states does it contain specific statements in regard to the effect of a pre-existing disability on the claim for compensation. However, the correspondents from 7 other states expressed opinions, based perhaps on interpretations made in disputed cases. For four states (Minnesota, New Hampshire, Pennsylvania, and Wisconsin) the statement was made that an existing disability did not enter into the question of compensation. The opposite reply (that injury must arise out of and as a consequence of the employment) was received from 10 states. Answers from the 2 other states were non-committal. In 5 states, decisions affecting employees killed or injured in an epileptic seizure have been handed down by the highest courts. In three cases, Kansas[5], New York[6], and Oklahoma [7], the employer was not found liable, and in two cases, Illinois[8], and Massachusetts[9], he was found liable. The reasoning of the court can be illustrated by the New York case. An epileptic employee while walking on the sidewalk fell in a convulsion and died from a fractured skull. The industrial board had awarded compensation, a judgment confirmed by the state supreme court but overruled by the court of appeals. This last court ruled that the fall was not due to the employment, it might have happened going to or from work. A fall from a ladder while at work might have been a different story. Two judges dissented, saying that a workman carries with him all his infirmities and the fact that he has them does not destroy his right to compensation. In England a boy riding a bicycle while at work had a seizure and was killed. He rode the bicycle at the behest of his employer but against the advice of his doctor, and the courts held the employer financially responsible.[10]

At first glance decisions which award compensation to the epileptic would seem advantageous to him, but actually they are

disadvantageous. An employer will not knowingly hire an epileptic if he (the employer) knows that he is to be held financially responsible for any injury which the epileptic suffers. In most instances the outcome of a hearing or trial depends on the circumstances of the case and on the opinion or bias of the board or court. The uncertainty of the outcome and knowledge that an appeal may cost several thousand dollars, warns the employer to "play safe" and not to play the good Samaritan. As a consequence of these conditions, a person who has seizures must conceal his disability, which means that neither he nor the employer are able to use safeguards against injury which might be used if the true state of affairs were known. A remedy for this unhappy situation would be a provision whereby the handicapped employee might waive his rights for compensation for injury sustained as a result of his condition. At present, seven States (Connecticut, Indiana, Kansas, Kentucky, Maryland, New Mexico and Wisconsin) permit an employee to reject the compensation code. But even this privilege is not satisfactory. The handicapped person deserves protection against injuries which are the direct result of his employment.

As will be shown, the majority of non-institutional epileptics are employed presumably because they are good workers and their seizures are either hidden or their employers are kind. Dozens of instances come to mind of epileptics who are working effectively for employers fully cognizant of their illness. A more general employment of epileptics would have a therapeutic effect by increasing the patient's morale and self-respect and would be an economic gain to the patient and the nation.

Suitability for Work

The injustice of the present situation is apparent but has received little attention in the literature except in Europe where sickness insurance is in force. Von der Heydt[11] reported that in Germany epilepsy caused one percent of premature disabilities, the average age of invalidism being 34.6 years against 53.3 for all causes. Two or more seizures a week were judged sufficient for the receipt of

benefits. Italian experience has been reviewed by Rizzatti[12] and Chiochi.[13] A list of suitable and unsuitable occupations for epileptics has been drawn up by Steininger[14] and the actual occupations of 78 patients by Ordway and Ryther.[15] Fox[16] found that 54 per cent of mentally normal young patients who had been discharged from special schools were satisfactorily employed.

For additional information concerning the employability and the occupations of epileptics we have examined the medical records of more than 1000 epileptics of working age. Detailed reports of these patients were submitted by neurologists throughout the country who cooperated in the studies and who saw these patients in their private offices or in public clinics. Their names appear in a previous report.[17] This statistical information is supplemental to the authors' own twenty-odd years of specialization in the study and treatment of epilepsy.

Physical Condition — The vital organs of these extra-mural patients, as shown by examinations of eyes, ears, hearts, lungs, kidneys, and so forth are organically sound, or as sound as any unselected sample of the working population. In respect to posture, general physique, endurance, quickness and so forth, epileptics probably average below normal, but this is not due to any inherent defect but simply to lack of work or training, or overuse of sedative drugs. Of course, the most serious cases of epilepsy begin in early childhood and because of death or assignment to an institution are sifted out of the general population before they become adult.[18]

Condition of the Brain — Since epilepsy is a disorder of the brain, the question of damage or dysfunction of this organ is most important. In 78 per cent of 1905 patients of all ages who were carefully questioned and examined, no cause for seizures and no evidence of antecedent damage to the structure of the brain was disclosed. The remaining 22 per cent gave evidence of having suffered some injury of the brain before seizures began. Disabilities of all sorts were more pronounced in this minority group.

The employer is not interested in causes or in the details of

examinations of the nervous system, but wants to know whether the prospective employee is capable of effective work. Fortunately, like other vital organs of the body, the brain may perform well in spite of definite damage, and only a fraction of those with evidence of brain injury have physical disabilities which would interfere with their productivity.

The following tabulation shows the proportion of the patients (about 1500 of all ages) who exhibited certain physical disabilities.

Muscular strength—strength reduced	8.2 per cent
Muscular strength—paralysis of muscles	0.6 per cent
Coordination impaired	7.2 per cent
Involuntary muscle movements (exclusive of fits)	4.6 per cent

The disabilities listed occurred several times more frequently among persons who had received brain injuries than in the total group. For the most part, the various disabilities occurred in the same persons. We may conclude, therefore, that about nine-tenths of epileptics in the community have normal muscular strength and control.

Even more important than the muscles is the mind. The association of mental deterioration and epilepsy has been grossly overestimated by doctors as well as by the public. Among 838 epileptics, 20 years of age and over, 67 per cent were judged by the examining neurologist to be mentally normal, and in only 9.2 per cent was gross deterioration observed. If those who had received brain injury are excluded, 70 per cent of patients were found to be normal. Severe impairment of neuro-muscular control and of mentality most often appear together. In the majority group of mentally normal, patients' intelligence quotients are widely scattered, in our experience reaching as high as 154.

Not only has mental defect and epilepsy been falsely associated in the popular mind but some doctors have suggested that epileptics possess a peculiar and unpleasant personality—self-centered, one-track minds, with short-lived interest in their work. These strictures apply to a very small proportion of patients, for the most part those who are mentally defective.

In conclusion, a certain proportion of adult epileptics, because of brain injury which has caused paralysis or because of mental deterioration, abnormalities of personality, or the frequency or severity of seizures, are not fit for employment. This proportion is small, probably no more than a third or quarter of patients in the community. Among those who are able to work, qualities of willingness, faithfulness, and eagerness to prove acceptable are unusually high.

More important than this survey of potentialities is the actual employment record of adult patients.

Occupation Experience of Patients

The examination blank asked about the ability of the patient to work. The following tabulation gives the answers from 608 men and 497 women, eighteen years of age or over, comprising respectively 84 and 82 per cent of those questioned.

PERCENTAGE OF PATIENTS ABLE TO WORK

	Men	*Women*	*All Patients*
Fully able to work	54	48	51
Partially able to work	24	34	28
Unable, because of seizures	19	15	18
Unable, for other reasons	3	3	3
Total	100	100	100

Thus only 21 per cent were listed as unable to work. In this group, epilepsy was the deterring condition in 86 per cent of the men and 83 per cent of the women.

Occupational Record—The following data refer to 571 men and 370 women eighteen years and over, who answered the question about past and present occupation. Information from another 7 per cent was not obtained.

PERCENTAGE OF PATIENTS OCCUPIED

	Men	*Women*	*Both Sexes*
Formerly occupied	97	92	95
Occupied at present	73	73	73

Of men and women who worked formerly, 98 per cent are now fully able, 92 per cent are partially able, and 90 per cent are unable to work. Of men and women who are occupied now, 88 per cent are now fully able, 74 per cent are partially able, and 34 per cent are unable to work.

Naturally, the proportion of the employed falls sharply with the working ability of the patient. Thirty per cent of the men and 42 per cent of the women now occupied were classed as unable to work. Probably these persons were for the most part students and housewives. These persons were included among the occupied because the fact of being busy is of more importance for the epileptic than financial return.

On the whole, the employment record of these patients is encouraging, especially in view of the fact that all the persons were seeking medical advice. However, we know that the positions of many of those employed are at the mercy of a chance seizure "on the job." This uncertainty, and the necessity for concealment make for impaired efficiency of work.

Occupations

The principal occupation, past and present, of each person was listed. The summarized results appear in Table I. A larger proportion of men than women are in business or in skilled work, a larger proportion of women are students or doing unskilled work, which category includes housework and housewives.

In comparing former and present occupations, the decrease of students matches the increase in the proportion of men in the professions and in business. Among the women the principal losses are in teachers, telephone operators, salesgirls, factory and restaurant workers, a total decrease from 65 to 23, and in the number of housewives from 68 to 17. The question of whether being a wife and mother is a proper occupation for epileptics lies outside the scope of this study. These summarized data do not indicate any regression in the quality of present occupations compared with those formerly followed. This inquiry did not include information

as to whether the former occupation preceded or followed the onset of the person's epilepsy.

Omitting students and housewives, 359 men and 157 women at the time of examination were gainfully employed. Among the men, 10 or 2.8 per cent, are physicians, and clergymen, dentists, engineers, lawyers, teachers and physicians constitute 14 per cent of the whole group. Among women, ministers, nurses, physicians and teachers make up 12 per cent. Among men, occupations most frequently named are: salesman 14 per cent, farmer 13 per cent, clerk 10 per cent, laborer 10 per cent, and mechanic 6 per cent. That 4 per cent of male patients are chauffeurs occasions both surprise and disapproval. Among women most frequent occupations are: stenographer 9 per cent, clerk 12 per cent, and housework 46 per cent.

The following present occupations of 359 men are grouped with reference to the number of persons reporting. Obviously some of the classifications overlap:

One to four reporting—chiropractor, dentist, veterinary, collector, newspaper work, shipper, butcher, cook, draftsman, jeweler, locksmith, fireman, hotel worker, laundry, messenger, seaman, dancer, musician, stage, writer, cowboy, professional sports, welfare.

Five to nine reporting—clergyman, teacher, banker, barber, clothing, grocery, insurance, electrician, medical technician, metal worker, plumber, railroad worker, carpenter, painter.

Ten to nineteen reporting—physician, mechanic, factory worker. Thirty or more reporting—salesman, farmer, laborer.

Following are the occupations of 157 women: one to four reporting—clergy, librarian, physician, psychologist, interior decorator, newspaper, real estate, salesgirl, store manager, beautician, billing machine operator, jewel setter, laboratory technician, printing, telephone operator, restaurant worker, actress, musician, painter.

Five to nine reporting—nurse, teacher, dressmaker, factory worker.

Ten to nineteen reporting—clerk, stenographer. Housework tops the list with 73 reporting.

Suitable Occupations — Since these data were collected, the outlook for successful medical treatment has been greatly improved because of the discovery of a more effective anticonvulsant drug,

dilantin (or phenytoin) sodium. Looking at the problem from the viewpoint of the physician, jobs not suitable for epileptics may be placed in three classes.

First, are occupations categorically forbidden because the lives of others might be endangered. These include the operation of fast moving vehicles, airplanes, automobiles, locomotives, elevators, street cars, or buses; positions of intense personal responsibility, major surgery, private duty nursing, trapeze performer, solitary watchman or lookout, swimming instructor, and so forth.

Second, is the operation of machinery of such a nature or work at such a height that temporary loss of consciousness might injure the patient or the machine; these occupations include house painting, bricklaying, carpentry, bridge building, steeple chasing, mining, welding, machine tool operation, and so forth. The use of safety appliances may, in some cases, mitigate the danger. For example, one of our patients works at a height, painting towers. He contends that he is relatively safe in this position because an attack at work leaves him hanging in his safety belts, whereas one in the street might leave him in the path of an automobile.

Third, are prohibitions which arise from popular reactions and prejudices. In this group, a controlling factor is the number of eyes focused on the person. The stage, the concert platform or the pulpit is a more vulnerable position than a desk or counter. Nevertheless, we have had as patients, ministers, college professors, public school teachers, legislators, and bankers. Positions which entail contact with the public are not inherently unsuitable, but their retention depends on the tolerance and intelligence of that particular segment of the public which may be onlookers, and on the popularity of the patient. When persons who make up the public learn that, fundamentally, epileptics are no different from themselves, and that a seizure is nothing to be ashamed or afraid of, the positions open to epileptics will be greatly enlarged.

A person cannot be advised flatly against entering occupations in the third group because treatment may prove to be successful, or public sentiment may be changed. In all cases, advice must be

fitted to the individual. Considerations which have weight for healthy persons(personal preferences and aptitudes, previous education and training, personality and financial resources) must in the epileptic be supplemented by considerations as to the number, frequency and types of seizures and the probability of successful medical treatment.

Having specified employments barred to epileptics or not suitable for them, the more extensive list of employments is, or should be open to them, either freely or with certain stipulations or safeguards.

In addition to those patients, happily in the majority, who are capable of doing full work at regular wages, is a small minority of persons who are seriously handicapped or without special training. The Auracraft Shop in Cleveland, conducted by Dr. Fetterman[19], and the Goodwill Industries of Chicago, demonstrate the feasibility of workshops for epileptics who cannot find regular employment. Pay for such work is below standard rates but the medical and psychological help which patients receive is more valuable than money.

Public Responsibility

For the people to support in idleness thousands of able bodied and able minded persons simply because they are unable to work for a few hours or days out of a year is extravagant folly. Between convulsive episodes which are weeks, months, or in some cases years apart, most epileptics are as normal as their brothers or sisters and perhaps even better able to do an honest day's work. In the United States, the average worker loses ten days a year because of accident or illness. The majority of epileptics are incapacitated by their disorder fewer days than this. For example, one of our secretaries has had approximately one hundred thousand petit mal, a near record as regards numbers. In the aggregate they represent approximately two weeks of unconsciousness. This time loss is much less serious than that occasioned by her colds.

An altered public opinion should bring about changes of labor laws which would permit patients to work at their own risk, so

far as injuries directly due to seizures are concerned and at a lower wage if his productivity is impaired. The employer should know the person's history in order to cooperate in measures which would lessen the danger of accident. As affairs now stand, the prospective employee must conceal or lie about his sickness else he would never be hired. Cooperation should include the doctor. The employer can employ a man or woman with more confidence if he knows that this person is under competent medical care. The Laymen's League Against Epilepsy is organized for the purpose among other things of a more effective employment of this reservoir of man power.

Summary

Adult epileptics in the United States when projected on the number of persons who are gainfully employed, form an army of some 350,000 men and women. The men are unreservedly excluded from the armed forces and with the irretrievably poor 4-F rating find it difficult to enter industry, labor hungry though it is. As a rule, employers will not knowingly employ an epileptic of either sex because of the prevailing ignorance about epilepsy and because of possible liability in case of accident. A review of the laws of various states with regard to compensation demonstrates the need for provisions whereby the epileptic may work at his own risk in the event that injury is the result of a seizure.

TABLE 1

Occupations, past and present, of patients fifteen years and over

	Former Occupations			*Present Occupations*		
	Men	*Women*	*Both Sexes*	*Men*	*Women*	*Both Sexes*
Number Reporting	581	387	968	563	416	979
Professional & Arts	8	7	7	12	6	9
Business	22	14	18	28	9	20
Skilled Work	15	5	12	14	2	9
Unskilled—						
Domestic Work	26	36	30	27	62	42
Student	29	38	33	19	21	20
Total	100	100	100	100	100	100

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PRESCRIBED OCCUPATIONAL THERAPY AND VOCATIONAL REHABILITATION FOR THE TUBERCULOUS

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The introduction of collapse therapy is one of several factors which have extended the period of hospitalization for tuberculous patients. In this lengthened hospital stay, medically prescribed occupational therapy and rehabilitation have a two-fold role. They aid in reconciling the patient to the prolonged hospitalization; at the same time, by assisting the patient in his personal adjustment, they contribute to his post-hospital life.

We do not intend to imply here that occupational therapy and rehabilitation are made available to tuberculous patients exclusively. For years, occupational therapy has been used in the treatment of mental disorders, of orthopedic handicaps, of post-operative cases. But we have concentrated our endeavors in working with the patients who have been handicapped by tuberculosis.

The occupational therapist is a professional person. By virtue of her personality and training, she should be capable of working constructively with patients. To function effectively, she should be able to enjoy working with deviates. Personality problems may develop from the patient's consciousness of his handicap and its potential effect on his post-hospital life. The therapist should have the ability to recognize such problems, and be prepared to help the patient in overcoming them. She should be able to maintain a friendly but nonpersonal relationship with the patient. The therapist should work with authority, but she should derive that authority from her own inner certainty of purpose. As a result of her professional training, she should be able to suggest activities appropriate to individual patients, and to give instruction in such activities. In a tuber-

culosis hospital, the competent and imaginative occupational therapist can make a definite and important contribution to the patient's total adjustment. However, the occupational therapist is an extra-medical member of the hospital staff. As such she should be ready to accept, as one of her fundamental working principles, the fact that the hospital is directed by its superintendent. The occupational therapy department is as completely within his supervision as are the wards, the operating room, the X-ray department, or any section of the hospital.

To the same degree as the occupational therapist, the rehabilitation worker should posses those qualities, a few of which have been suggested above, which will enable him to work constructively with handicapped persons. Through his contact with the patient, the rehabilitation worker helps him to decide which phases of the occupational therapy department and the hospital's adult educational facilities will be most helpful to him in his eventual adjustment.

Of the two workers, the occupational therapist has the closer contact with the patient during his early hospitalization. The first activity medically prescribed may be reading or bed-side crafts. In occupational therapy, library service can become a basic step. To be effective for bed-patients, bedside service should be made available to them on a definite schedule of at least two visits weekly. The patient's initial selection of books should be based entirely on his own choice. Eventually he may seek guidance. Then the therapist's recomendations, based on the patient's reading experience, hobbies, vocational background, interest in current events, or subjects in which he has shown an interest, may stimulate him to direct his reading into another level. Brief book reviews can arouse a patient's desire to know more about books and their authors.

As the patient improves, the attending physician may give permission for him to do some type of light handicraft while still confined to bed. The therapist then explores the patient's interests in leisure-time activities which are within the prescribed exercise range. Sewing, knitting, crocheting, soap or clay modeling, drawing, and painting are some of the crafts which patients select. In addition

to providing a recreational outlet, crafts bring patients a sense of achievement. Through this library and bedside craft service, the therapist has the opportunity to observe the patient's mental and emotional pattern and his work habits.

It is important that the rehabilitation worker become acquainted with the patient as soon after his admission as the physician may authorize. During the stages of low activity, the rehabilitation worker retains his contact with the patient by means of bedside visits. Thus the patient is made constantly aware that with retrogression of his disease, additional phases of the in-hospital program will be available to him. Through consultation with the attending physician, the worker keeps himself informed of the patient's medical status. By means of his access to the occupational therapy department's case records, the worker has the benefit of that department's observations of the patient's personality pattern and work habits.

By recording the patient's family background, his educational and occupational history, his stated likes and dislikes, the rehabilitation worker gathers the tools which assist him to aid the tuberculous patient. If the need for aptitude tests is indicated, the worker administers them as soon as the medical permission is obtained.

A wide-range knowledge of job opportunities is essential to realistic guidance in vocational rehabilitation. Awareness of current occupational trends in the individual patient's home community is implicit in sound vocational counseling. Consequently, a working relationship between the rehabilitation worker and agencies existing beyond the hospital boundaries, such as the departments of education, the state rehabilitation bureau, the public employment offices, and the personnel divisions of nearby industrial plants, is vital in obtaining the fullest measure of service for the patient.

In actual practice the rehabilitation program often starts before the patient has reached the ambulant stage. With the cooperation of the occupational therapy department, his reading may be directed into educational and vocational channels. It may be indicated that the patient should be enabled to study blueprint reading, farm management, radio repair, bench motor assembly, or aviation mechanics.

It may be that the patient's physical condition will permit him to return to his former occupation. In that event, he may be interested in knowing more about the men who founded or advanced his trade or profession; it may be that he "never had time" to refresh his mathematics, or to brush up on his English. If his physical condition makes it necessary that he change his occupation, he has the opportunity now to prepare for that with the guidance of the rehabilitation worker. Helpful correspondence courses are available. It often assists both the patient-student and the school if written assignments are "handed in" through the rehabilitation department. In such instances that department maintains a calendar of due dates and is in a position to observe the degree of faithfulness with which the patient performs his assignments.

Modern in-hospital rehabilitation programs feature adult education, usually in cooperation with the county or state department of education. Patients who had never completed their secondary education have a chance to obtain their high school certificate, often an asset in vocational competition. For the ambulant patient, there are courses in shorthand, typing, accounting, woodwork with motor driven tools, radio repair, and printing.

Courses in nutrition, step-saving suggestions in household work, classes in sewing, may give the housewife material hints and helps. Without such training the housewife, whose "woman's work is never done," is more liable to have a reactivation of her disease than members of any other occupation or profession.

It is quite possible that the patient's leisure-time activities may be transferred into vocational assets. For example, the aim in teaching art in a hospital is not primarily to produce artists, but to stimulate the patient's visual perception. Too, the skills which are developed through art work — perception of design, pattern and harmony, accuracy in noting pictorial detail — are definitely transferable to specific vocational situations. However, when the occasional patient shows definite talent and skills in such directions, the ultimate vocational exploitation of such talent should be realistically explored. The applied arts include such occupations as photography,

dress design, illustration and commercial art work.

The services which the combined occupational therapy and rehabilitation program offers the patient are made available to him on a basis of graded activity. This degree of activity is dependent on his clinical status, and is determined by the medical staff. When a patient's condition remains stable throughout a specific level of activity, for a definite length of time, the medical staff may consider him eligible for advancement to the next level of activity. Through this process the patient establishes his work tolerance. Whether he will be able to return to his former work, or whether his physical condition makes it imperative that he find new employment, his employer will expect to be shown some authoritative evidence of the patient's physical stability. The patient who establishes his work tolerance through a program of medically graded activity has a record in black and white, over the signature of a physician, to exhibit.

It should be noted here that in many instances cited, the facilities of the hospital are utilized to provide physical build-up for the patients. The general office with its filing, typing, shorthand, accounting; the switchboard; the patients' store; the medical records room; the X-ray department; the laboratory — all these provide ready-made opportunities for physical build-up under supervision.

A balanced occupational therapy and rehabilitation program makes provision for the social adjustment of the patient. Directed group activities help him to develop ability in oral expression, ease in meeting social situations, self-assurance, tolerance of individual deviations in temperament. These are immeasurable assets to the person in normal work situations. An effective device for social stabilization in an association of the patients within the hospital, conducted by them and operated for their mutual welfare.

We have indicated above a few of the direct contributions which medically prescribed occupational therapy and rehabilitation can make to the tuberculous patient. Our approved occupational therapy schools must meet the requirements of the American Medical Association. From these schools are being graduated persons who have

been trained to work with patients. This work is a spoke in the wheel of medical treatment with which the modern tuberculosis hospital strives to service its patients. The moral and financial support of the community is essential to the effective workability of this rounded program. The patient who can be induced to remain in the hospital until his scar tissues are healed, has a fairly good chance of returning to his community as a tax-payer rather than tax-consumer.

REHABILITATION OF THE TUBERCULOUS IN ENGLAND

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The Interdepartmental Committee on the Rehabilitation of Persons Injured by Accident defined rehabilitation as the arrangements for the restoration of the working capacity of persons injured by accidents . . . restoration "to the point when his condition is restored to the pre-accident state and he is able to resume his previous occupation or, in cases where full restoration is not possible, until the fullest possible measure of restoration has been effected." The Committee point out that in the full meaning of the words the definition would cover the whole range of treatment from the time of the occurrence of the accident.

Care and After-Care

The problems of rehabilitation of the tuberculous are the problems of rehabilitation in general. But, in addition, tuberculosis presents problems of its own, because it is a chronic infectious disease for which there is no specific cure; treatment therefore depends largely on mustering the patient's resistance. The modern treatment of pulmonary tuberculosis dates from the end of the last century with the introduction of sanatorium regime — that is, varying degrees of rest, with plenty of nutritious food, in a country institution in which superventilation is practised. To this was added graduated exercise, for which the autoinoculation theory appeared to provide a scientific basis. At that time the criteria of diagnosis were crude, and the patients subjected to sanatorium regime undoubtedly included many who were suffering from non-tuberculous conditions or from quiescent lesions. The regime led to quiescence of localised active lesions, and it improved the general condition of

other patients. But it soon became evident that the improvements and even so-called cures were seldom maintained after the patients returned home, and that relapses occurred oftener and sooner the worse the social and economic conditions to which the patients returned.

As sanatorium treatment was the best treatment available at that time, blame for the ultimate bad results of treatment was thrown on the post-sanatorium environment. There followed the conception of "after-care," soon followed by that of "care," when it was realised that unless the patient was looked after immediately the disease was diagnosed he might be unable to avail himself of treatment in sanatorium at all, or at all events to remain there for the period required. But another result also followed, which I believe still to be retarding the full acceptance of new methods of treatment. Sanatoria clamoured for more and earlier cases so as to justify the sanatorium principle. As the number of beds increased, this demand became increasingly difficult to meet, and because radiological examination of the chest was in its infancy, "early tuberculosis" was confused with tuberculosis that will yield to sanatorium regime. Unfortunately this principle is still carried on in many sanatoria. And, presumably because some lip service is paid to bed rest and collapse therapy even by these institutions, we repeatedly hear the importance of after-care emphasised without any reference to treatment, which is assumed to be efficient in all sanatoria. But we cannot begin the study of the problems of after-care and rehabilitation without exact knowledge of what treatment offers.

Arrangements Inadequate

What was the position of care, after-care, and rehabilitation before 1939? Each local authority must provide a tuberculosis scheme which, given some sort of dispensary and institutional beds, conforms to the letter of the law; the extent to which the spirit of the law is applied is left to the conscience, and knowledge or ignorance on tuberculosis matters, of the local authority and its medical

officer of health. The Interdepartmental Committee on Tuberculosis stressed the importance of care and after-care, but there is no compulsion on the part of local authorities to provide such arrangements, although they may do so. Care and after-care committees exist, some purely voluntary, others partly connected with public health departments; but their work, with practically no financial backing, is but a drop in the ocean and can do nothing to solve the problem of rehabilitation. Even these arrangements do not exist in connection with half the tuberculosis schemes in this country.

The National Association for the Prevention of Tuberculosis, which stimulated the formation of after-care committees, fails to stress the insignificance of the work that is being done in relation to what needs to be done. The following is a conclusion of the Employment Committee of the Joint Tuberculosis Council in 1935: "The work of care and after-care committees throughout the country is not co-ordinated. In a large number of areas there is no committee functioning at all. There is still evidence of over-lapping in many districts between care committees and public health committees, and no real improvement in the financial provisions for care work has been noticeable during the past five years." Attempts to provide training colonies have proved abortive and, in spite of the enormous and favourable publicity the village settlements of Papworth and Preston Hall have had for so many years, they still remain the only institutions of this kind. The absence of after-care arrangements almost nullifies any results obtained by treatment, and the reasons for this neglect, I think, are two. First, there is confusion as to what and how much is required, because only superficial attention has been paid to the facts on which care and rehabilitation arrangements must be based; these are: the outlook for tuberculous patients in various circumstances, how this outlook may be changed by the application of recent methods of therapy, and for what types of patients and for what proportions of them provision has to be made when treatment is completed. Secondly, under our present system of industrial enterprise and social organisation, a solution to the problem, both satisfactory and comprehensive, may not be possible.

Outlook for the Tuberculous Patient

The reports of the Employment Committee of the Joint Tuberculosis Council on Care and After-Care Schemes in Tuberculosis have exposed the thoroughly inadequate arrangements existing at present. E. Brieger, of the Committee for After-Care and Rehabilitation of the International Union against Tuberculosis, has compiled a report which not only indicates the importance of social and economic factors, but stresses the significance of adequate treatment. Brieger presents a method of statistical analysis on which any practical arrangements should be based now and in the future.

In recent years, during which methods of diagnosis and treatment of tuberculosis and social medicine as a whole have made much progress, the mortality has greatly decreased, but is this result due to lessened incidence or to an improved outlook for the individual tuberculous person? If more tuberculous persons survive, does this mean an increase in the number of permanently disabled or of permanently healed? And does an improvement in the methods and results of treatment lead to a reduction or an expansion of after-care activity?

As compared with pre-sanatorium statistics, no evidence can be produced to show that sanatorium regime by itself has increased the expectation of life. On the other hand there is statistical evidence that the social and home conditions of the tuberculous patient, and his earnings and work after discharge, noticeably influence the expectation of life. But during the last few years another factor has been introduced. In the present state of our knowledge sanatorium regime, generally and unfortunately referred to as sanatorium treatment, retains its place, but only at the stage when treatment proper has been completed or has done the best it can. The treatment proper of pulmonary tuberculosis, termed "combined intensive treatment," is based on three main principles: (1) bed rest until quiescence of the lesions is obtained; (2) collapse therapy as soon as it is indicated, and by this is not meant indiscriminate collapse therapy; and (3) effective application of collapse therapy by additional surgical measures at the earliest moment indicated.

Taking into account the evidence available, we can no longer regard those who oppose these principles in full as merely expressing a difference of opinion. We must ask whether laziness for intellectual effort is not sometimes behind the desire for so-called conservative treatment which avoids the decisions and anxieties about when to induce the pneumothorax, at what intervals to have the refills, when to cut adhesions, when to decide on a thoracoplasty. Do we not in fact lean more and more on conservative treatment as we get older, not because we have always learned deep wisdom, but because our mental faculties have become insufficiently elastic to deal with active treatment? Very few institutions as yet apply extensively all the three principles I have indicated. Enough statistical material for analysis is available, and one can state that so far as good immediate results are concerned modern intensive treatment is the most important factor. This is shown by the increasing proportion of patients discharged sputum-negative with increasing application of combined intensive treatment. But we must also determine whether the ultimate results have improved following intensive treatment.

Effect of Modern Methods

Therefore Brieger examined how far the recent changes in diagnosis and treatment of pulmonary tuberculosis have altered the outlook for the patient. The fatality rate in the pre-sanatorium period, in the sanatorium but pre-collapse period, and since 1920, when collapse therapy may be said to have been initiated on a general scale, were all determined. The analysis shows that the increase in survivors after 5 years in the years since 1920 was about 20%. Does this improvement in outlook for the tuberculous patient mean that there is an increase in complete cures, or does it merely mean that the life of still active and therefore infectious cases is prolonged? We must determine the outlook for a patient who is discharged still sputum-positive, and that of the patient with no sputum or sputum-negative. Brieger refers to these cases as $++$ cases and $+-$ cases.

TABLE 1

	Sputum + — cases	Sputum + + cases
Alive after 5 years (America)	70%	30%
" " 6 " (Holland)	81%	36%
" " 6 " (Germany)	73%	34%
Expectation of Life		
Midhurst } Frimley }	3 years	1 year

The after-history of the + — cases, as based on statistics of certain British, German and Dutch sanatoria, and on collected American statistics (King) shows that they have a good expectation of life. (See Table 1.) But there is a strong tendency for these cases to become sputum-positive again — that is, to relapse. There is little doubt that some of these so-called relapses result from lesions that were not really quiescent when the patients were discharged from the sanatorium (it is in this connection that the new bacteriological methods of culture of the sputum, gastric contents and laryngeal swab examinations are of such help at present); but even in these patients a further spread of reactivation of disease must have occurred. According to most workers one-half of the sputum-negative patients discharged from sanatorium became sputum-positive within 2 to 5 years. But the more intensified the treatment and after-care, the less is the tendency to relapse. Unfortunately only a few institutions give the proportion of + — cases discharged, but if we assume that "quiescent" is the nearest approach to it, we find, for instance, that in England and Wales in 1938, 12% of 25,568 sputum-positive cases (of which 32% were classified as T.B. + 3 on admission) were discharged as "quiescent." In Wales alone, in 1938, not more than 3.8% of 1,746 sputum-positive patients were discharged as "quiescent" (of whom 59% were classified as T.B. + 3 on admission). It is quite evident that the proportion of + — cases is collectively very small though it may be much higher in individual institutions. In 1938, 25% of the T.B. + patients (on admission) were discharged as "quiescent" from Clare Hall Sanatorium, Middlesex, although the material admitted to this institution was very poor indeed: no less than 69% of the T.B. +

patients admitted were classified as T.B. + 3. At Cheshire-Joint Sanatorium, in 1938, 54% of the sputum-positive patients admitted were discharged sputum-negative (42% being classified T.B. + 3 on admission), but the term "quiescent" is of course stricter than absence of tubercle bacilli in the sputum.

The outlook for the + + case is, as I have already indicated, bad: 70% died during the first 5 years after discharge from sanatorium. But we must recognise that the bad outlook does not apply to all the patients in the group. Indeed, a small group among them have a very good chance of surviving. Lawrason Brown and Sampson have defined this group as "good chronic cases," and spoken of the others as "bad chronic cases." Table 2 represents a follow-up of these two groups.

TABLE 2

Lawrason Brown and Sampson's Cases

	Alive after 5 Years	At Work after 5 Years	Alive after 10 Years	At Work after 10 Years
Good chronics ...	80%	54%	60%	52%
Bad chronics ...	37%	12%	25%	11%

A good chronic case who has worked for 5 years has the prospect of 5 more years at work, but even a bad chronic case who has been at work for 5 years has the prospect of a further 5 years' work.

Fate of the Discharged Patient

Before we can appreciate the problems of after-care and how these problems may be affected by changes in therapy, we need some precise information as to what happens year by year in these different groups of discharged sanatorium patients as regards survival, fitness for work, and infectiousness. Brieger was able to analyse the material of two sanatoria in these respects. The first study concerns patients discharged from Münchbach between 1920 and 1927, when between 16% and 32% were discharged sputum-negative each year, the condition of patients discharged in these years being known

in 1929. The final results in this year were, of course, due to alterations in the proportion of + — cases to + + cases owing to deaths and relapses. (See Table 3.)

TABLE 3 (After Brieger)
Münchbach Sanatorium, 1920-27

	Incapable or only Partially Capable of Work	Good Chronics	Stabilised + — cases	Dead
After 2 years ...	36% (all die in subsequent 7 years)	15%	15%	30%
After 9 years ...	10%	10%	10%	58%

(a percentage of patients were untraced)

How modern treatment affects the outlook in the above respects is seen from analysis of patients from Bilthoven Sanatorium in Holland. Each year-group was checked year by year, and only 2% of patients remained untraced. The patients can be grouped in three lots: those discharged in 1921-5, those in 1926-9, and those in 1930-2. Since during this time the proportion of patients discharged sputum-negative had greatly increased as a result of combined intensive treatment, it is best to compare the years 1930-2 with those of 1921-5, the proportion of sputum-negative cases being 66% in the latter period and 34% in the earlier.

Let us consider the 1921-5 group first and follow up the + + cases, representing 66% of all patients discharged. Nearly two-thirds of them (representing 40% of all discharged patients) were dead within 4 years, the remaining third, or 21% of all those discharged, were classified as good chronics — after two years only one-fifth were incapacitated or only partially fit for work, but after eight years they were almost all alive, and all those with full working capacity after two years were still capable of full or partial work after eight years. It was found that the outlook for the + + case becomes fairly clearly defined after two years. After eight years we are left with about 12% of the total discharged patients who

are "good chronics," the remainder of the + + cases having died except for a small percentage who are entirely or partially incapacitated. (See Table 4.)

TABLE 4 (After Brieger)
Bilthoven Sanatorium

	Incapable or only Partially Capable of Work	Good Chronics	Stabilised + — cases	Dead
Patients Discharged, 1921-5, when 34% Sputum-Negative and 66% Sputum-Positive				
After 2 years ...	35%	15%	20%	26%
After 4 years ...	23%	14%	18%	42%
After 8 years ...	13%	12%	19%	55%
Patients Discharged 1930-2, when 66% Sputum-Negative and 34% Sputum-Positive				
After 2 years ...	34%	6%	38%	16%
After 4 years ...	22%	8%	40%	28%

These results agree with those of Münchbach.

Let us now consider the + — group, which represents 34% of all discharged patients. Two-thirds of the whole group, constituting about 20% of the total discharged, are alive after 8 years, but, of these, some, representing about 5% of total discharged patients, are partially or totally incapacitated, and in fact they became so in the first 2 years after discharge. The relapses, which represent about one-third of the + — cases, take place in the first 2 years after discharge, and the group pronounced stabilised after 2 years remains so.

In the years 1930-2, 33.4% + + and 66.6% + — cases were discharged. At the end of 2 years the good chronic cases formed only 6% of all discharged. After 4 years, 14% of the patients discharged were chronic infectious, 8% good chronics — as compared with 30% and 14% respectively in the 1921-5 group. In the 1930-2 period, after 4 years, the proportion of stabilised cases to relapses in the + — group is 1.6 : 1 as compared with 1 : 1 in the 1921-5 period. The relapses, however, are high: during the first two years they represent 25% of all discharges.

The outlook for the + — group on discharge is "conditional" (Brieger). Of those discharged as fit, nearly half relapse during the first 2 years. But after 2 years a group of stable + — cases was formed and it continues unchanged for the next 2 years. And as a result of combined intensive treatment the number of stabilised cases is doubled. The ultimate as well as the immediate, results of intensive treatment show a remarkable improvement as compared with results of sanatorium regime alone.

Functions of After-Care

The importance of treatment must be stressed in any consideration of rehabilitation; intensive treatment does not reduce the need for after-care; by reducing the deaths and raising the proportion of + — cases it enlarges the need for temporary after-care for the latter. At the same time it does not appreciably decrease the proportion of those needing permanent after-care, for this group, consisting of all + + cases and relapses from the + — cases, still constitutes after 4 years nearly one-third of all those discharged from institution. But whereas with sanatorium regime as treatment after-care of this class predominated, with intensive treatment it is the temporary after-care of the + — case that does so. In 1921-5, the proportion of + — stabilised to + + stabilised was 1.3 : 1, in 1930-2 it was 5:1. Brieger thus concludes that after-care develops a direct connection with therapy, and the need is for arrangements in which treatment and temporary after-care are found in the same institution.

The above results are not an indication of what happens in all sanatoria in this country or abroad. Many factors enter which make strict comparisons impossible. But these considerations detract in no way from the conclusions that can be drawn from the analysis of the case material at Bilthoven. These conclusions are:

1. With intensive modern treatment some three-quarters of tuberculous patients can be rendered sputum-negative and quiescent.
2. Most of these discharged sputum-positive die off quickly, but an appreciable proportion are able, though bearing active lesions and infectious, to do full work for years.

3. Of those discharged sputum-negative, an important proportion relapse.
4. Stabilisation as regards the permanently arrested and the good chronics is largely determined at the end of two years after discharge.
5. The influence of modern intensive treatment is considerably to increase the proportion of arrested stabilised cases.

After-care has therefore two functions to perform:—

(*a*) In regard to + — cases, to reduce the number of relapses through temporary after-care.

(*b*) In regard to the + + group, to transfer to hospital those very ill; to segregate those less ill in order to prolong life, ensure their livelihood and check transmission of infection; and to rehabilitate the good chronics, that is, those capable of full work but who cannot secure their livelihood without harm to themselves and others.

The more intensive the treatment in sanatorium, the greater the proportion of patients who require temporary after-care as compared with those who require permanent after-care.

Working Capacity

Social legislation provides inadequate payment for complete disablement only, for a period much too short in respect of tuberculosis. A patient discharged from sanatorium, whether he is sputum-positive or sputum-negative, whether really able to do work or not, therefore attempts to get some sort of work in order to live. Such work he can generally obtain only by hiding, with varied degrees of success, his health history — a procedure that does not help in maintaining self-respect or give a feeling of security. About one-half the patients discharged from sanatorium find their way back to an occupation. Many endanger not only themselves but also others, particularly in occupations such as those involving the handling of food or looking after children. Many eventually become too ill to do any work, or die, but a large proportion go on working for years, though this does not imply that they are really fit for work. On the other hand, some who cannot do full work would be able to do some work under favourable conditions, and in the aggregate this represents an asset to the community. As Brieger puts it, can this asset be realised under present conditions?

There are institutions that consider all sputum-positive patients as unfit for work, although some of them are perfectly capable of

work, and, on the other hand, some consider any positive-sputum patient as fit for full work if he has been able to do a couple of hours gardening and a two-mile walk a day under sanatorium conditions. In actual fact, the estimate of working and earning capacities is of fundamental importance and these cannot be judged merely on the basis of clinical diagnosis. The wage-earning capacity of a sub-standard worker must be estimated by physiological methods and economic considerations — principles which are used in industrial research, where medical opinion is constantly sought. This is specialised work, and it cannot be assumed that all tuberculosis officers or medical superintendents have a natural aptitude for it. For many patients correct assessment requires not only clinical intuition but the application of certain tests and watching under actual working conditions, which are far removed from what comes under the term "occupational therapy." Brieger puts it: "It is rather a fiction than a fact that exercises or works in the sense of occupational therapy can be successfully used as an efficiency test"; and again: "Work therapy becomes a test only when it is carried out in the form of regular employment — that is as routine work of vocational character." The conditions under which the laboratory efficiency tests, such as the ergometric test, are carried out are artificially produced and do not really correspond to the conditions of industrial life. The function of efficiency tests is, however, to discover any latent dyspnoea, so that directions can then be given which will cause the human machine to be used both economically and sparingly in relation to its functional reserve.

Capacity for work depends not only on the physiological tests for efficiency, but also on what has been termed the psycho-technical suitability of the patient to vocational labour. Many patients have had only an elementary education without any vocational training. A low physical standard may be compensated by technical or mental superiority, and a fully-skilled worker temperamentally suited to his work will have a high standard of efficiency even with a physical defect. Thus, a great deal more than even functional tests must be known about a sub-standard worker before he can be rehabilitated.

Up to the present I have confined myself to discussion of pulmonary tuberculosis. Adults suffering from so-called surgical tuberculosis form a much smaller group, but the problems of rehabilitation apply no less to them. In fact the problem in their case is complicated (1) often by some permanent disability in a limb, and (2) by the fact that their lesions are part of a chronic disseminated tuberculosis. This suggests that for most such persons, even if quiescence of lesions is obtained, more or less permanent after-care is indicated.

After-Care and Rehabilitation in Practice

After-care and rehabilitation depend on the composition of the "ex-sanatorium" material. The term "ex-hospital" would be preferable. There is in fact no longer any justification for retaining the term "sanatorium." First, there are disadvantages in singling out by name the institutions for the treatment of a particular disease. Secondly, because of the name many sanatoria which have no adequate facilities for the modern treatment of pulmonary tuberculosis "get away with it." Thirdly, the conditions as regards situation in the country, etc., are no more essential in regard to a tuberculosis hospital than in regard to any hospital. Fourthly, the term "sanatorium" is connected in patients' minds with an institution for curable cases only. Lastly, it would be advantageous if all cases first diagnosed could go for assessment to the institution however short the stay in it, rather than that this assessment should be done hurriedly and badly in the dispensary, many people who might benefit by treatment thus being deprived of it through a faulty estimate of their condition.

Of the patients leaving the institution after completion of treatment, two groups can be discussed briefly:

The first comprises those who are complete invalids and need admission to hospital for a short time until death: here it is necessary to ensure the economic life of the family, but this is merely a continuance of what must have been carried out before.

Secondly, there is, at the other extreme, a group of patients who on their history and clinical findings may be considered completely healed, and be

allowed to return to their old job or to another suitable job without an interval. These probably form a small group at present, particularly where an insufficiency of beds limits the period of treatment after quiescence is obtained. But I believe it will form a gradually increasing larger group as more and more cases of early bronchogenic tuberculosis are detected by mass radiological examinations and are adequately treated. The small risk of relapse among these patients can be lessened by persuading the employers to make slight arrangements for the benefit of these patients. I have in mind such points as allowing them to begin work a few minutes later in the morning and leave a few minutes earlier in the evening, so as to avoid the rush and discomfort in travelling; the provision of a small rest room where the workers can lie down for half-an-hour or so during the lunch hour; a longer annual holiday; and so forth.

The three main groups we have to cater for are: (1) those quiescent patients who need a period of industrial convalescence — that is, work under good hygienic and physical conditions and medical supervision so that arrest of the lesions can be established by the end of the period, and they can then safely be allowed to go back to ordinary industrial conditions; (2) the group of "good chronics" who need employment under sheltered conditions for the rest of their life — that is, the sub-standard workers; (3) the group of "bad chronics" who under suitable conditions can do some work for a number of years. Therefore the problem is to provide temporary sheltered employment, and to provide permanent sheltered employment.

Temporary Sheltered Employment

According to the Report of the International Union Against Tuberculosis, temporary sheltered employment might be organised in the following ways:

1. Intelligent patients who are not under the necessity of earning their full livelihood could in some cases, under medical supervision, create the conditions of industrial convalescence at home.
2. Half-time work and financial compensation for reduced wages may be a good alternative.
3. By means of temporary sheltered employment on the staff of the sanatorium in which treatment was initiated.
4. By attaching industrial colonies to sanatoria. This is considered the ideal solution for temporary sheltered employment. The work is not to be

considered as a hobby or as so-called occupational therapy, but there must be one or more independently organised industries with a certain turnover and full pay for the workers.

5. Urban workshops.
6. Industrial settlements of the Papworth type.

Industrial convalescence at home and half-time work are likely to be possible for only a small proportion of patients under the present system of social insurance. I shall refer to this again later. For employment on sanatoria staff important difficulties, which I shall mention later in connection with permanent sheltered employment, must be overcome, but at the best it cannot solve the problem of temporary after-care for all those who require it. Industrial settlements were not designed primarily for temporary but for permanent after-care. They seemed all-important at a time when the group needing permanent after-care was the main problem of after-care. This, as I have shown, should no longer be true. Industrial colonies attached to sanatoria, and urban workshops are the most likely practical measures for temporary sheltered employment.

Permanent Sheltered Employment

So much for the quiescent case. For the non-quiescent patient the alternatives are fewer. For him the sheltered employment must be permanent. He is and remains a sub-standard worker. The conditions of work must be adjusted to make his output as normal as possible. It is obvious that the earning capacity of such workers can be assessed only in special industries (as in those connected with sanatoria), and they must be retained in similar sheltered industries. At the same time, of course, such industries cannot be built up with sub-standard labor unless the capacity of the workers is known.

The *bad chronic cases* surviving after two years, but unfit or partially fit for work, present a great problem. I cannot convince myself that the work of these can really be utilised in any industry, although it is obvious that some of these people could do some work at home. The institutional segregation of these patients offers immense difficulties whether this is carried out by urban settlement scheme, incorporation with industrial settlements, or in hostels or

homes. It is particularly in regard to this group that the principle employed in the part-time sanatoria established in Russia deserves close study, assuming that work could be found for them through usual industrial channels. Henry E. Siegerist gives the following description of them:

"Patients who are able to work, but require some regular treatment and care, are admitted to these sanatoria. They arrive at about six o'clock in the evening after working hours, have a hot shower or bath, change their clothes, and have dinner. Afterwards they rest for an hour or two, if possible on porches; their temperatures are taken, and they are examined by a physician. They spend the time from eight until ten o'clock in the club of the institution or in undergoing medical treatment. From ten in the evening until six the next morning they are expected to be in bed. They then have physical exercises and breakfast, and return to work. Persons on night shifts are admitted to day sanatoria in the same way. A very important function of these part-time sanatoria is the education of patients. They are taught how to live properly in order to improve their condition."

The *good chronic cases* form a larger group unemployable in ordinary industrial life. The Employment Committee of the Joint Tuberculosis Council sent a questionnaire to 220 employers asking whether they would employ in their industry 1% bacilliary part-time workers. Only 25% answered, and these answers contained decided refusals. Obviously an employer is concerned only with working capacity, and so long as there are enough unemployed fit workers there seems no reason why he should employ those disabled in any way.

THREE METHODS. — The solutions offered have been (1) employment in sanatoria; (2) urban workshops, such as the Altro workshops in America; and (3) industrial settlements such as Papworth. It is impossible here to go into full details concerning these schemes. Individual institutions such as the Altro workshops are doing excellent work; and, similarly, Papworth has been of immense propaganda value in attracting attention to the problems of after-care. But taken as a whole they have solved the problem of after-care and rehabilitation for not more than an insignificant proportion of those involved. In fact, the success of individual

institutions may be largely due to their remaining unique, and thus obtaining facilities, consideration, and financial help which might not be forthcoming otherwise. Many of us believe that a large number of patients could and should be employed on the staff of sanatoria when quiescent, but it is doubtful whether this could be done on a large scale with good chronics — certainly not at present. Local authorities oppose the employment of both groups because of superannuation regulations and the risk of relapsing to a state of incapacity for work. It is time that even if these people were not on the sanatoria staff the local authority would need to pay for their treatment again. In fact, a relapse occurring when on the sanatorium staff is likely to be diagnosed earlier and therefore lead to saving in expenditure on treatment. But at the same time a number of people would have to be available immediately to replace those going sick.

As regards sheltered workshops, attempts to develop them here have certainly not been successful, for obvious reasons. Who is to run them? Who will provide the initial capital for their construction and equipment? The same local authorities who at present do not even provide an X-ray apparatus in any of their dispensaries? Can these industries compete with the output of normal industries without a deficit, and by whom will this deficit be made up? As regards industrial settlements, the difficulties associated with them are those I have already mentioned in connection with urban workshops, with the additional difficulties associated with colonisation. Papworth and Preston Hall have proved a success as industrial undertakings in spite of great handicaps, but how far have they been a success in solving the problem we have been discussing? To my knowledge no details of the personnel at work in either institution have been published, and one wonders, therefore, how far the success of the settlements has been due to the use of labour from patients whom we would call "stabilised arrested," and therefore fit to return to normal industrial life.

Sheltered Industries. — After studying the report of the International Union Against Tuberculosis, it may be concluded that the

best after-care scheme for the quiescent and the good chronics consists in having connected with each sanatorium sheltered industries in which all patients whose treatment is completed would pass through a period of industrial convalescence; those becoming stabilised would be absorbed into normal industrial life, and others would settle in these sheltered industries, a settlement gradually being built up with them. This pre-supposes the following conditions:

1. The first is the existence of well-equipped and well-staffed sanatoria in which modern intensive treatment is carried out. These do not exist throughout the country. The present arrangement by which each local authority, big or small, rich or poor, progressive or backward, guided by a medical officer who is or is not properly informed on tuberculosis matters, with a Ministry of Health which leaves it to progressive authorities to act as an adequate stimulant to others, even in regard to the provision of X-ray equipment — this arrangement, I say, is not likely to lead to the establishment of such sanatoria throughout the country.

2. Assuming the existence of such sanatoria, which would need to be planned with due regard to local incidence of tuberculosis and the probable need of post-treatment arrangements, sheltered industries and settlements might well be built up provided the capital were available. Under the present system this could hardly be provided by separate authorities. In fact the more one sees of tuberculosis work, and the more thought is given to the control of the disease, the clearer does it become that the present handling of tuberculosis under separate local authorities is wasteful, ineffective, and out of date. Tuberculosis as a whole must be tackled nationally. I cannot convince myself that a National Rehabilitation Board alone, as has been suggested, will do much if the rest remains as it is now.

3. It is assumed in the Report that the stabilised arrested workers after their industrial convalescence will return to their old jobs or find others. But will this always happen? The history of tuberculosis and the long absence from normal industrial life will almost certainly handicap them in relation to other workers.

4. The fact that Papworth and Preston Hall have remained the only industrial settlements suggests that under present conditions the establishment of such settlements in competition with normal industry is very difficult, probably more difficult than appears on the surface if one only knew the composition of the workers in them. These industrial settlements were not intended and should not be used for the stabilised arrested case. And, indeed, Dr. McDougall, Director, Preston Hall, has repeatedly stressed this point during the last few years.

Social Insurance

Under National Health Insurance no special provisions are made for the tuberculous patients. Nor does it provide compensation for people permanently disabled. The sum allowed is not adequate either in amount or in length of time to enable the tuberculous person to live without work. The slight increases recently passed do not affect this conclusion. It is astonishing that, while the local authority is prepared to pay £5 a week for the treatment of the patient in sanatorium for an indefinite period, the same patient when discharged from institution — although it is known that he needs special care and is liable to relapse within the next two years, when further expensive institutional treatment will be needed — should be considered as amply provided for with the 7s. 6d. a week from National Health Insurance. Tuberculosis falls in a class by itself in that it is a chronic incapacitating disease involving constant danger to the community as a whole. This alone justifies exception in regard to the benefits of National Health Insurance.

National Health Insurance, or some other system of insurance, should provide (*a*) an adequate sum on which the patient may live when not working during the period when stabilisation is being established, and (*b*) an adequate sum or pension on which to live for the chronic who has no work.

I do not suggest that this arrangement should be adopted in lieu of the schemes I have outlined, and certainly not that it is better for the patients concerned not to work at all — work is essential for proper adjustment to one's social environment — but, failing adequate schemes of after-care and rehabilitation, such financial compensation, available when the patient has no work, would be of distinct benefit and could be applied immediately. I need hardly add that the financial arrangements under the Poor Law Assistance Board do not meet the case.

In a Report prepared by a Committee of the Socialist Medical Association of Great Britain the suggestion is made that under National Health Insurance there should immediately be made available a cash allowance generous enough to provide for the relatively

high standard of living that is necessary for the tuberculous patient and his family contacts. This, it is stated, means that the allowance must be enough to avoid his having to live on relatives, to send his wife out to work, or to apply to the Public Assistance Committee. It is further suggested that on notification every new tuberculous case would go into a first category which would entitle him automatically to receive the special National Health Insurance benefit without question for, say, a period of 12 months, because few working-class patients should return to work before this period has elapsed. At the end of the 12 months his case, together with that of the family contacts, would be reviewed by the tuberculosis officer (preferably acting in consultation with another physician or with a local board), and the future financial benefit would be decided upon according to whether the patient is at work, or according to the likelihood of return to work. Patients likely to have to remain idle indefinitely may at this review be placed under a second financial category.

This would, of course, not solve the problem of rehabilitation. The theoretical basis of this as outlined above appears sound, but it is difficult to see how it can be applied under the present conditions of tuberculosis control and under conditions of private industrial enterprise. Under the latter, competition is based solely on getting the largest profit for the individual or shareholder concerned. Under State industrial enterprise competition would still exist in that presumably the State would endeavour to obtain the most productive work possible from its workers and concerns, but, being responsible for the whole community, it could arrange the industries so as not only to absorb all available labour, but also to use substandard workers, with whom we are concerned here. The difficulties to be met when industry is under State control and how they can be overcome is illustrated in the following account from Siegerist's book *Socialised Medicine in the Soviet Union:*

"A decree passed in 1935 by the Commissariat of Public Health and Trade Union Council requires directors of all enterprises to make special provision for tuberculous workers, their working hours may be reduced and social

insurance funds will make up the balance of the wages. All larger factories have special dietetic dining rooms for such persons. In a factory in Kharkov they have their own workshop, called the prophylactic workshop. In a rubber shoe factory they have their own conveyor which moves more slowly. Since all enterprises have a definite plan for amount of production, it is obvious that a large proportion of tuberculous workers handicaps a plant so that many managers are not enthusiastic about employing them. In a radio factory in Veronezh the difficulty has been overcome by letting tuberculous men work as a special group outside the plan. Thus they do not handicap the enterprise, but add to its production figures. In more serious cases invalids from tuberculosis have organised co-operatives where they perform light work under medical supervision. Tuberculous patients are kept in their customary surroundings whenever possible. If they are skilled workers, every effort is made to prevent them from dropping to the ranks of the unskilled on account of their illness."

Without central control of both treatment and industry, a comprehensive solution of the problems of rehabilitation of the tuberculous, and for that matter of rehabilitation in general, may not be found. One might ask what is to be done now? I would reply, we must concentrate on improving treatment, stimulate the development of a satisfactory social insurance scheme, and do some intelligent planning of after-care for the time when circumstances will make its application practical.

In the preparation of this paper I have leaned heavily on the Report compiled by E. Brieger for the International Union Against Tuberculosis. I freely acknowledge this debt.

PROBLEMS INVOLVED IN THE REHABILITATION OF THE DISABLED IN ENGLAND

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The discussions now taking place in political and medical circles are surely the harbingers of developments which may be expected in the post-war years. Of these, none is more prominent than rehabilitation. Most of us are quite clear in our minds as to the limitations which may be placed on the word itself, for it has been our custom to reserve it for the technique and devices which are employed in restoring physically or mentally handicapped individuals to their rightful place as economic units in the affairs of the country. The word should not be used in any less restricted sense.

It has, perhaps rightly, been a criticism that medical practice has fallen short of this ideal. The dramatic results which follow the successful treatment of the acute appendix, the perforated ulcer, the frank lobar pneumonia, and so on, and which bring our patients speedily and safely back to the tasks in which they were previously employed, obscure the fact that in many other cases such an ideal solution is quite unattainable by the means at present at our disposal. It must be admitted that there is some division of opinion amongst medical men themselves as to the scope of their obligations in this matter. Each disease or infirmity which we are called upon to treat has its own degrees of severity. Let me take as an example the disease with which I am specially familiar, pulmonary tuberculosis, one of the most difficult to deal with from the rehabilitation point of view. The great majority of our patients are severely disabled, many are infectious, the relapse rate is high; they are, in addition, still subject to public prejudice despite the intense educational propaganda carried on since the beginning of the century.

Mildly Disabled Patients

No matter how successful the treatment, not more than one-third of all patients admitted to sanatoria for treatment are likely to return to their former occupations. True, we can stem the progress of the disease so long as the patients remain under treatment, even when the lesions are quite extensive. But it is the common experience of all workers in this field that relapse is a constant menace even under ideal hygienic surroundings and continual medical supervision, and special methods must be applied in this disease if rehabilitation in the usually accepted sense is to be attained for the majority of our patients. The one-third of our sanatorium patients who are sputum negative and who have limited deposits in the lung tissue are very much in the position of the orthopædic patient who requires a period of specialized treatment with a certain amount of physical re-education by graded exercise. These persons provide a relatively minor problem to public health authorities, for they are well supervised after they leave the sanatoria, and experience has shown that the prognosis in such cases is, on the whole, good. The members of this group can be easily rehabilitated by purely medical means and come within the same category as that which includes the acute appendix caught in time or the perforated ulcer which has been dealt with with all speed; although the time element in recovery may be longer in the pulmonary case the end-result is the same — complete rehabilitation.

Severely Disabled Patients

But specialists, and in fact the general public, are fast realizing that we are not rehabilitating in the same way the thousands of patients who do not fall into this simple category. There is a growing and widespread feeling that greater effort should be made by those responsible for patients who are never likely to return to their previous occupations and who, therefore, must be given, as part of their treatment, the necessary facilities to enable them to lead an economic life which, if not as full and complete as that of their less handicapped brothers, is yet a solution of their own problem

and, equally important, of that of the nation. Orthopædic surgeons would, I believe, be the first to admit that there is a considerable loss of time in bringing many of their patients to complete economic rehabilitation owing to the lack of adequate opportunity for physiotherapy in many parts of the country. This matter is well within the province of hospital authorities themselves and especially of local authorities since the majority of rehabilitation measures are essentially medical, or can be conducted and supervised by medical men and competent physiotherapists. We are far behind the pre-war German methods in prescribing physical exercise in orthopædic cases if we are to judge by the work done at Hohenlichen by Gebhardt for limbless patients. They exercised entirely without mechanical support of any kind, boxing, swimming, vaulting and playing football in their anxiety to obtain the special concessions which a pre-war Germany awarded to men who were adjudged physically fit to return to ordinary industrial work. The incentive was financial as well as medical. That physical reeducation can go to such extremes is obvious, and the records of the present war show that severely disabled men — completely legless, in fact — can perform prodigious feats when an incentive is present.

Need for specialized training. — There are large numbers of the disabled in all categories, however, for whom specialized methods over a long period of time are necessary if such persons are to be even relatively self-supporting. The medical profession and the public alike are now being called upon to devise the technique necessary for this most difficult problem. What are we to do with the patient who is never likely to return to ordinary industrial life, even after medical and surgical treatment in the wards has done everything possible to remedy the pathological aspect of his disability? Are patients who may be capable of a limited amount of work under medical supervision to be discharged *ad infinitum* from hospitals to live a parasitic life on meagre local authority and charity funds? The very thought is abhorrent to the majority of patients themselves and is equally detestable to the majority of physicians

and surgeons. Only specialized methods will suffice for the grossly disabled orthopædic patient, the "nerve" patient who is suffering from slowly progressive but only remotely fatal disease, the "middle" and chronic ambulant tuberculous patient and the "heart" patient who must lead a life within certain limits. The financial loss to Great Britain due to the present method of subsidizing from public funds the tuberculous who come into this category has reached a staggering figure, yet the vast majority of tuberculosis physicians, at any rate, know too well that only by allowing such patients to work within the limitations of their physical resources can life be maintained and a living earned. Undoubtedly there are differences of opinion. Some medical men feel that rehabilitation on the lines of continued supervision and adjustments of the more severely disabled in special industry does not come within the medical province at all. Lay administrators, on the other hand, frequently take the view that as the patients are still patients in the purely medical or surgical sense and are outside the pale of ordinary industry, the task is essentially one for doctors. Between these two schools of thought the problem of the severely disabled has been so neglected that, with a few outstanding exceptions, there have been no vital contributions to their economic welfare in the whole history of Medicine.

Example of Papworth and Preston Hall

The work done in rehabilitation in tuberculosis at Papworth, Cambridgeshire, and at Preston Hall, Kent, and elsewhere in this country has been pioneer and may well serve as a basis for further consideration of the subject. The important point to be noted by those who are interested in this special problem is that the rehabilitation of the tuberculous was a medical man's idea from its inception. It was proposed by the late Sir Robert Philip at the beginning of the present century and put into practical operation by the late Sir Pendrill Varrier-Jones at Papworth. It has had ample public and medical support, and the results medically have proved that it is practicable in every way. Experience in such places as

Papworth and Preston Hall has proved that in times of peace, and still more in war-time, orders of sufficient quantity can be obtained to keep large numbers of seriously disabled tuberculous patients at full time and part-time work under ideal hygienic conditions. Constant work, security of tenure, standard rates of wages adjusted in individual cases, medical supervision for dependents, good housing and excellent workshops have resulted from a carefully-planned scheme now known as the Village Settlement. Since the war, however, it has been the experience at both Papworth and Preston Hall that with ample orders forthcoming from Government departments many of the pre-war difficulties have disappeared entirely. Orders come in from sources from which previously they had to be secured in the face of severe competition from outside industry. It was this factor of business competition which acted as a deterrent to many local authorities who applauded the work of such settlements for the tuberculous but who were afraid to embark on the financial risks which such an experiment involved.

Preston Hall accommodated itself to the altered conditions at the very outset of war. New machinery was set up, Government contracts were obtained, considerable extensions were made in the livestock section and office staffs were increased to meet the growing demand. A few healthy men were imported to help in the type of work which was considered too arduous for the fittest of our settlers, but the great majority of posts — and certainly all the more important ones — have been manned by patients and ex-patients. Over £70,000 has been paid in salaries and wages to tuberculous settlers since September, 1939. The turnover in the industrial section has more than doubled itself. It could have been quadrupled by importing more healthy people to undertake the work, but we have resisted this temptation and have kept as closely as possible to the original ideals of employing disabled people only. The output in terms of goods manufactured has been prejudicially affected, but our standards have remained and we have the satisfaction of knowing that even under the stress and strain of war the fundamental principles have remained unaltered.

Suggestions for National Rehabilitation Board

If it has been possible to obtain such results in a disease like pulmonary tuberculosis with its numerous hazards and administrative difficulties, how much easier would it be to establish similar undertakings for the rehabilitation of other types of disability if some of the industrial problems could be overcome? The Rehabilitation Committee of the Joint Tuberculosis Council has a clear-cut contribution to make in its newly published report. Briefly, it is suggested that without state intervention rehabilitation schemes of all kinds are likely to remain parochial and in the hands of voluntary organizations supported by limited public and private donations. The establishment of a National Rehabilitation Board with regional areas throughout the country is suggested as a solution to the problem; this would enable part or whole-time employment to be given to large groups of necessitous patients. The National Rehabilitation Board would act as contractor-general to local authorities and the Government on the lines laid down in an article to the *Times* by Lord Willingdon on 13th January, 1940. It is not suggested that the Village Settlement should be the only centre for such rehabilitation endeavours, but rather that the Village Settlement, itself reserved for the more severe patients, should also be the centre from which regional activities should originate. Regional growths would then be proof of regional success.

By some such modification of existing practice the main difficulty which has confronted existing schemes and which has prevented local authorities from taking a more active part in the initiation of such schemes would be removed. The present war has demonstrated conclusively that with active government and local authority cooperation it is within the competence of the disabled, working under the conditions applying to sheltered employment, to contribute substantially to the nation's resources in the manufacture of goods for use in war. Such cooperation can surely continue through into the time of peace.

Conclusion

The conclusion, therefore, is that in rehabilitation schemes on a large scale it is not solely a matter for either the politicians or medical men. It is a problem for both. The evidence which is available shows that we have a long way to go before we can be in a position to deal resolutely with the many patients who demand rehabilitation under sheltered economic conditions. But until public opinion enables medical workers to make the path of the more severely disabled easier, and until politicians give us the necessary power to explore further along the economic avenues which have proved suitable for the severely disabled, we are never likely to obtain the results we desire and which our enthusiasm deserves.

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REHABILITATION BY MODERN METHODS OF EXERCISE

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Weightless Suspension Exercise

During the war of 1914-18 a trained masseuse had an inspiration regarding the treatment of a patient who had paralysis, and whose weight was about 20 stones. She suspended him by ropes and pulleys and was thus able to cope with the massage and exercise required for the condition. From that idea has grown a progressive system of weightless suspension exercise. In January, 1931, an article appeared in the *British Medical Journal* by A. E. Porrit and Olive F. G. Smith, describing the original suspension exercise for exciting incipient movement in weakened and paralysed muscles. This pioneer work was done at St. Mary's Hospital and at the Swedish Institute, London. The whole system has been developed now so that it can deal with early or acute, subacute and chronic conditions; it takes a definite place in the patient's daily life, from the moment he sustains trauma, or is fit to start movement in recumbency. Weightless suspension exercises can be progressed by careful graduation from simple suspension and relaxation up to resisted exercise for muscle toning. These exercises are all active, i.e. done by the patient, and so his cooperation and attention are ensured.

Description of Apparatus

The apparatus and the aids which we find useful for such graduation may now be described. First there is the standard metal unit suspension frame from which the patient can be suspended wholly or partially. If the patient is recumbent in bed, it is a common-sense idea to give easy exercise of this type, and so the patient can enjoy weightless activity.

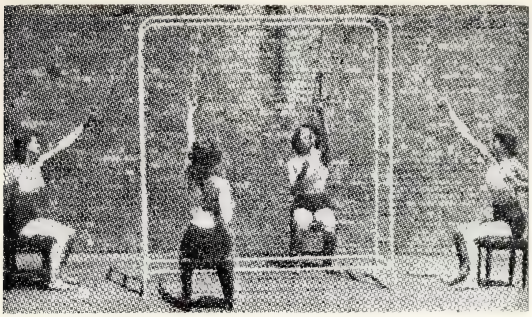

FIG. 1. Standard metal unit used as portable gymnasium for group treatment.

Fig. 1 shows a standard metal unit. It is made of steel tubing, 1½ inch gauge, and has multiple adjustments for ropes and gear. It is in fact a portable gymnasium and is most useful for group treatments. The metal unit can be dissembled into three main parts by the tapered bolts which hold the sliding joints in place. Makeshift units can be made out of a double Balkan beam and can be fitted over a bed; even a single Balkan beam is better than nothing. (See Fig. 2.) The single beam apparatus is useful for the treatment of limbs and in situations in which there is only one case in a ward. In some sector hospitals an overhead suspension apparatus is used in order to save floor space. Ropes and gear can be obtained separately from a sail maker.

Methods in Use

The methods now in use for suspension exercise are as follows:

1. Relaxation as a preliminary to exercise, and interspersed with bouts of exercise.
2. Suspension for weightless exercise.
3. Auto-assisted exercise for joints.
4. Graduated resistance exercise for muscle training and muscle toning, making more and more effort to get the patient to work hard and do it himself while he is carefully kept under supervision, so that adjustments and suspensions may be corrected.

Rehabilitation Suspension Exercises

Rehabilitation suspension exercises are all active and are applied as described below.

1. *Relaxation.* — The suspended body is an ideal medium for quick and deep relaxation before any form of treatment is begun. The keynote of this form of exercise is to gain the co-operation of the patient in his own cure. (Se Fig. 3.)

2. *Weightless activity.* — This type of treatment is suitable even from the stage of initial treatment in recumbency. At first a pendulum swing is all that is necesary, then five grades of progressive work are arranged by the operator until muscle toning work of the heaviest type can be introduced by methods recently adopted. The movements are performed entirely by the patient under the supervision of a skilled operator. Since much repetition is possible without fatigue, these exercises help to restore normal controlled movement.

3. *Auto-assisted exercise for joints.* — Pulley exercises of auto-assisted type are all double sided and the movements are reciprocally opposed. When the injured part is carried by momentum of the alternate action past the point of pain which the patient dreads, he will accomplish more than he thought possible. In functional conditions the chosen movements should be those which are quick, small, and rhythmical; with an increasing range the patient's sense of position is confused and the inhibition of movement lessened. The to and fro movement of the rope on a pulley is easy to perform,

FIG. 2. Makeshift Balkan beam unit with ropes and gear.

and encouraging to the patient, while the gentle rhythmic muscle work helps to relieve spasm and tremor, and promotes confidence and relaxation. (See Fig. 4.)

Technique

Before the apparatus is adjusted the therapeutic aim for the patient's movement must be thought out and explained in simple terms to the patient, so as to gain cooperation. The importance of a taut rope must be understood. For instance an injured limb is placed in a bent position for an easy start with the sound limb in stretch. As the good limb bends, it stretches the injured limb by its weight, but if there is a slack in the rope the whole effect is lost when the movements are progressed to the limit of the patient's reach. The patient's position should be based upon Swedish remedial positions, e.g. half-lying or high-ride sitting to fix the pelvis, and so on. Personal supervision of these points is essential.

The exercise can be given in three ways.

1. *Passive movements.* — The good limb may do all the work and the injured limb is pulled up and returns by its own weight, controlled by the good limb through the rope circuit.

2. *Active bilateral movement.* — This is done in small range

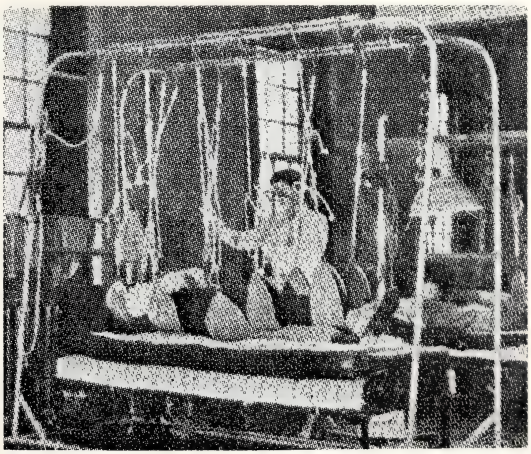

Fig. 3. Patient in suspension as a preliminary to exercise.

with rhythm and counting. It reduces tension, and the range of movement can be gradually increased as pain decreases.

3. *Active energetic action.* — This gives full range of movement of the injured limb and then the good limb will give overstretch to the weakened one by its weight.

Advantages of Modern Suspension Exercise

The modern method of sling suspension exercise is an advancement on the older Swedish remedial exercise. The fundamental positions are used, such as lying, half-lying, sitting, stoop-stride-sitting, and so on, but whereas the usual remedial exercise is given for a short period after massage treatment, these newer exercises can be done at definite periods of the day, and in the Sector under my supervision the daily programme is spaced so as to include physiotherapy when necessary, physical training, games, occupational therapy (orthopaedic and diversional) and set periods for suspension sling exercises. By this means the patient is treated as a whole, mentally and physically, and there is a spirit of healthy competition to perform these exercises. Indeed the patients express a liking for the suspension sling exercises, especially while recumbent, and many keep a record of progress.

There is an advantage in being able to select certain movements to train and tone up muscles for a particular type of work, and combined with occupational therapy in certain cases, the speed of recovery is undoubtedly greater than in patients treated only by occupational therapy. Weightless exercise by the suspension unit is a means of giving a patient all the advantages of pool treatment, with the added advantage that it's dry, and so chill can be avoided and exercise can be given in recumbency while the patient is in a general condition unfit for hydrotherapy. As with all new ideas of treatment there tends to be a swing over abruptly from old methods to new, and some authorities advocate occupational therapy to the entire exclusion of physiotherapy.

Recently two cases came to my notice in which an enthusiast for occupational therapy kept the fractured limb in plaster for months

and then when the bones had repaired removed the plaster and sent the patients home to do household duties as a form of prescribed occupational therapy. The patients did not appreciate the pain and weakness, and, after trying courageously to carry out instructions, went elsewhere for help in their difficulties. After a few treatments by short wave therapy, pain was relieved, but spasm and fear of movement remained. Suspension exercises were given, and within two weeks full movements followed, and the weakened muscles recovered their tone, so much so that the patients said they could immediately do home duties as occupational therapy with pleasure. Incidentally the X-ray examination in one case showed early arthritic changes.

For rehabilitation to be satisfactory, all the weapons at our disposal must be used judiciously, and it is essential for those in charge

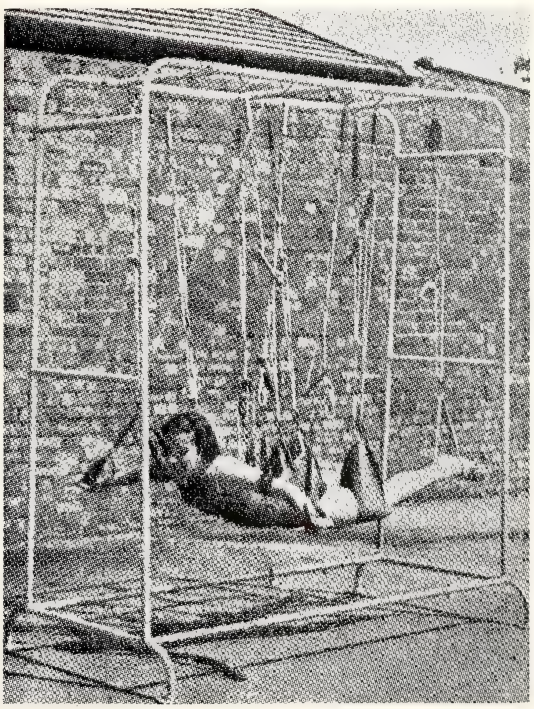

FIG. 4. Buoyant suspension—swimming exercise. The couch has been removed for the photograph.

of rehabilitation work to have a full knowledge of all types of treatment and the experience necessary to make judgment sound. In this way over-enthusiasm for one or other form of therapy can be obviated. The psychological effect of early active exercise in recumbency, graduated to active resisted exercise, is enormous. Patients are able to rise from their beds in good physical condition after weeks in recumbency and walk far sooner than they would otherwise. Persons with amputated limbs can be trained in bed and made sufficiently strong to employ crutches at once on rising and the stay in hospital is usefully curtailed. By ingenious methods of multiple joint work the patient while still recumbent is taught how to walk and is prepared mentally and physically for getting up. As soon as he can attend the gymnasium, progressive exercise is provided for him to be taken for a certain period each day. Concentration on performance is necessary and the adjustments of springs, slings and weights calls for cooperation and interest in development of muscle power and control. In functional cases particularly, inhibition of movement is lessened and healthy movement encouraged.

It is impossible in an article of this length to give fuller details of physiological, anatomical and mechanical effects of suspension exercise, but those who are enthusiastic over this system may be interested to know that in the near future a book is being published on the subject, in which these and other details are fully discussed.

Summary

Modern methods by suspension exercise enable a patient to have active exercise graduated from recumbency to active resisted work. Bilateral pulley exercises, owing to good leverage and traction, have special effect on joints and their structures and are useful for mobility. Rhythmic movement is obtained. Pulleys and weights are useful for graded muscular resistance and muscle tests. Springs have varied uses, for suspension only or for resistance work. By transference of the weight of the body to the apparatus many factors are eliminated which hamper movement, particularly in a patient who is weak or in pain.

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REHABILITATION IN NON-RECOVERABLE EYE CASES

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When damage to the eyes bring the patient near to or within the blind category—even if not permanently—he is best handled in a community in which all are much on the same basis, and in which specialized and practised help can be given.

Essentials of Early Treatment

In a general hospital or at home the blind person tends to get too much, or occasionally too little, done for him. He needs time to recover from the early shock of catastrophic blinding, but at this stage he can be enormously helped by his surroundings. While he must be allowed plenty of time for sleeping and resting by day, the rehabilitation of his spirit can be gently started; he should be encouraged to dress and shave himself, to be tidy in appearance and to put his clothes and belongings away in such a manner that he may readily find them later. He should, as soon as possible, feed himself, at first with a spoon from a soup plate, later with knife and fork from the usual plates, on which the food is served cut up. He should learn the geography of his surroundings so that he may get about alone in familiar rooms walking correctly and without apprehension. In this the cooperation of those about the man is most essential. The initial guidance and explanations and the elimination of obstacles such as chairs left about and doors left ajar are all important. The man who has a bad crash when just getting some confidence may as a result suffer a setback, the effects of which are often surprisingly lasting. All these points are so much better understood and arranged in the specially adapted community in which the addition of guide rails and ropes, strips

of matting on corridors, bumpers on corners of walls, and other aids, all add to the man's safety and encouragement.

Mental Reactions

Even to learn these simple things can and does produce considerable mental fatigue, and this is more readily understood when the acute mental depression caused by sudden blinding is taken into account. The depression and melancholy varies much in different individuals; in some it seems surprisingly little, but in all to a greater or less degree the sudden loss of sight and all it means, and the "slowing up" of all activities, is bound to have a profound mental effect. Especially in cases in which the blinding seems so lightly accepted, a later reaction must be watched for. The novelty — almost excitement — of the new surroundings with its kindliness and cheerfulness must pass, and commonly with time the realization of the position will produce a late mental depression—sleeplessness, worry, irritability, and so forth. The handling of this phase is often difficult, and is always of great importance. A change of scene to home and friends for a short time — an easing of efforts to "learn to be blind," and individual care and talk with understanding and experienced people, will all help to improve matters and get the patient going cheerfully again. Whether in an early or late stage, the companionship of other men, some with some degree of vision, some totally blinded, means that each and all give mutual help in one way or another. What may almost be called a competitive spirit upheld by a tradition, is a useful aid, although a weaker member must never be allowed to suffer from the appreciation that another is moving faster than he is.

Using the Hands

As the man settles and appears to be acquiring some confidence, he should be encouraged to use his fingers in simple ways at work and at play. He can learn to make string bags, wool rugs, and later to do simple joinery. Taught by blinded instructors, the men very quickly take to carpentry and use of tools, more especially if there

is a pre-existing inclination and ability. When skill is shown, carpentry is carried much further, but every man is coaxed to try it as early as possible. The more he is helped by blind companions and blind instructors, the more firmly is his confidence and spirit regained.

Further Progress

The patient may play dominoes (the dominoes have raised markings so that the values can be felt by touch) and soon get very astute at the game. He will be encouraged to dance and get exercise and enjoyment from it. If he has any bent towards singing and music and acting, such arts are fostered. Exercise is of great importance although it must be judiciously controlled in the early stages when fatigue is so readily induced by effort, mental or physical. Walking with suitable escort, physical training in small doses, gymnastics with ropes, punchball, wall bars, rowing and cycling machines, offer the necessary variety, and later kicking a football, tandem cycling, rowing, and similar more strenuous sports add a wider choice for the more experienced.

Reading and Writing

Learning to read and write comes in as soon as it seems that the man can stand the necessary mental effort. Typewriting is usually easily learned and skilfully managed by even the most unpromising. Braille is a much harder job; some types of patient make the heaviest weather of it, others are remarkably quick. Touch, patience and placidity seem to play a much larger part than intellectual ability.

Vocational Training

While the earlier stages are being negotiated, the man, by what he hears and what he is told, begins to learn the outlets possible in the way of vocational training, and this is started as soon as it seems wise. St. Dunstan's, by research and the co-operation of leading industrialists, has added to the usually accepted vocations suitable for the blind, and the bent and potentialities of each individual are

weighed when a choice of training course is considered. All training, whether as a means of rehabilitation or for the man's future, must be given in an intensity within the mental effort of the individual blinded man, and considerable care based on experience and intelligent observation is needed so that no undue strain may be imposed on a nervous system already the victim of a shattering blow.

Psychological Considerations

Except when obviously called for, specialized technical psychological treatment is not used at St. Dunstan's. This is possibly an omission open to criticism, for the assessment of the individual and the effects of the catastrophe of sudden blinding on that individual might give most profitable results in rehabilitation and training. The general trend has been to minimize as much as possible the "pathological" aspect of the blinding, and to rely on the buoyancy and adaptability of youth in the surroundings of other blind men, guided and helped by men similarly blinded in the past, and by experienced social workers and teachers. To ensure that the early contacts of a newly blinded man are as sound and as helpful as possible is an ideal hard to maintain but always attempted.

Medical and Surgical Treatment

Doctoring should be discouraged as much as possible. Surgery on account of facial injuries, sinuses and other conditions, is often needed, and if it can be done in the blind surroundings it is of the greatest advantage. The nervous strain, bolting of food from early lack of interest in eating, over-smoking and too little exercise, all tend towards gastric disorders and constipation, and these require to be controlled with an intelligent appreciation of the position, giving scope for the minimal addition to the introspection which blinding so often forces upon a man. The use of dark glasses may be a medical necessity, especially in eyes having some vision in spite of severe injuries. Many men prefer to continue their use for cosmetic reasons. As a general rule this is discouraged, especially in cases in which good artificial eyes are carried or the blinded eyes are not

unsightly. The use of glasses and artificial eyes must be approached with discretion in individual cases. In spite of tactful explanations of his state to a blinded man, there is often held a lingering hope that the sight may return — even in the absence of eyes — so that the suggestion of enucleation of shrunken eyes and use of artificial eyes may mean a finality which the man is still trying to shelve. This is all in keeping with the ruling that although the men rehabilitate best in a community, each man needs to a greater or less degree individual handling to nurse him over his mental shock and physical disability, and to start him soundly on the road to a successful and useful life within the category of blindness.

REHABILITATION IN OPHTHALMIC CASES

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REHABILITATION IN RECOVERABLE EYE CASES

From the practical point of view rehabilitation in recoverable eye cases can be most usefully described under two heads: first, the functional rehabilitation of those who have suddenly been visually disorientated e.g., by the loss of one eye or by the development of acute muscular imbalance; secondly, the physical rehabilitation of those who are convalescing from an ocular disease or injury.

Functional Rehabilitation

In the first category, measures to accommodate the patient to the loss of an eye are relatively simple. The principles to be observed are rapid restoration of physical fitness, training to compensate for the loss of binocular vision and to readjust the faculty of orientation, and measures to overcome the psychological distress of mutilation. These ends are attained by physical training exercises in which, in addition to toning up the system generally, special attention is paid to re-educating the sense of equilibrium and the judgment of distances by means of parallel bars, jumping and balancing exercises; this is implemented by organized games out-of-doors, particularly ball games, which are rapidly stepped up in speed, and organized indoor games such as ping-pong and billiards. The more sedentary part of the day is spent in occupational therapy; this can be of great value, the best results being obtained by weaving on a big loom and the performance of other tasks involving rapid and fine coordination between eye and hand. Finally, in the development of what might be called "uniocular confidence," the psychological aspect is by no means of least importance. Handling by the medical and nursing staffs should be encouraging but very matter-of-fact; emphasis should

be laid on the wide scope in both military and civil life for the one-eyed person, as exemplified in an Admiral Nelson or a General Wavell; while association with others who are in a like condition but have now realized the smallness of the disability from both the practical and cosmetic point of view, is of the first importance. Partly with the intention of producing comfort and hygiene of the socket and partly to stimulate self-confidence the utmost care should be taken that the first artificial eye is well-fitting and good-looking; the patient should not be returned to duty until this is ensured.

Acute Muscular Imbalance. — Acute muscular imbalance depends essentially for its rehabilitation on orthoptic exercises combined with gradual restoration of the general physical tone. Such cases occur, for example, after an accident to an airman or a driver, particularly when it involves a head injury, while not a few have been the result of prolonged visual strain such as that which occurs typically in look-outs at sea, aerial observers and drivers in convoy. A short period of complete rest, with omission of reading, is followed by an intensive course of orthoptic exercises with the synoptophore and with prisms; this combined with graduated physical training and increasingly active games almost invariably restores the patient to functional efficiency.

Physical Rehabilitation

The second group, containing those convalescing from a disease or injury of the eye which will leave them with good vision, includes the majority of cases which require rehabilitation. In these the objects to be aimed at, apart from the appropriate medical treatment, are the gradual resumption of tasks requiring visual effort, the restoration of physical fitness, the maintenance of military interest in those who can return to the Services, the institution of new interests of economic value in those who cannot, and for both the combating of the insidious mental and physical inertness which so readily afflicts those who are unable to see well or read during a long convalescence. For these purposes the most useful avenue of approach is that in

which a judicious balance under close supervision between active physical exercise, suitable sedentary occupation, organized relaxation, games and mental stimulation is preserved. To this end the hospital is divided into groups as follows: bed patients; patients who can undertake sedentary occupations; patients who can do light physical exercises; and patients who can undertake all activities. The following methods are employed.

1. *Occupational therapy,* the arts and crafts selected being on an ascending scale, starting with those which depend more on touch than on vision, and finishing with those which require a high standard of precision and workmanship. To a large extent these can be varied according to the talents of the men, and more than any other means excite their interest and maintain their confidence in complete visual recovery.

2. *Organized walks,* starting with small purposeful excursions and developing eventually into hard cross-country expeditions of definite military value.

3. *Physical training,* starting with the type of simple arm exercises which will not upset an invalid eye, and finishing with full-dress physical training, carried out in the open or in the gymnasium.

4. *Organized games,* particularly those of visual value, starting with jig-saw puzzles and advancing through billiards, ping-pong, darts and clock golf, to more energetic games such as medicine ball, rounders, cricket and football.

5. *The maintenance of interest by entertainments* and lectures most satisfactorily given by the men themselves on their particular Service speciality or experiences, a much more easily attainable and successful ideal than is commonly realized, particularly in a hospital where the three Services are represented.

Principles of Technique. — The actual methods and technique which may be employed in the rehabilitation of such cases may be varied within wide limits according to the facilities available, provided two guiding principles are borne in mind. Initially, tasks and exercises should be well within the limits of the visual capacity of

the patient, however poor that may be, and should be stepped up gradually as he improves so that his confidence is gained at the start and maintained throughout his recovery. Not less important is the maintenance of his morale and interest in life by the organization of communal activities and recreations in which poor vision is no handicap, an ideal difficult to attain in a general hospital or convalescent home.

PROBLEMS OF REHABILITATION LEGISLATION

By HOLLAND HUDSON
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Manpower shortage and the impending return of disabled men and women from the military services have turned a floodlight of public interest on the subject of rehabilitation. Many bills were introduced in the 77th Congress looking toward soldier rehabilitation or revision and enlargement of civilian rehabilitation or both. Much of that legislative drafting bore the appearance of hasty work. However, the intent and the public interest behind these bills is so valid that the problems which must be met in effective vocational rehabilitation deserve mature consideration.

In drafting legislation for rehabilitation, whether at Federal or state levels, the first problem encountered is clear statement of intent. The more overtly and unmistakably this intent is set forth in the language of the Act, the less frequently applications of the Act can be whittled down by indifferent or hostile interpreters. Interpretation will depend most of all upon the language of the Act because few will go back to preliminary hearings or debate for guidance.

What, then, is intended by the passage of a proposed Act? Is the objective a reclamation of potential manpower, which war has taught some of us, all too tardily, to value as a national asset? Is it further to reestablish the social security of a large group of citizens who have been made insecure by accident or illness? Is it to lessen a growing burden of public dependency? Is it to supplement orthodox programs of general formal education?

If any or all of these objectives are intended, definite statement may prevent delimitation, in regulatory procedure and in application, which reduces the effects of the legislation to less than the scope intended. In the recent past some of the states, having inferred from Congressional debates such objectives as those enumerated,

have stretched the law and their regulations as far as their legal advisors would permit. But during the same period other states have delimited their service so drastically in applying the Vocational Rehabilitation Act of 1920 and its amendments, that they have aided chiefly those physically handicapped persons who were least in need of such service. Thus, the contribution of such legislation to manpower is made insignificant; it can then add social security only for those who are least insecure; it can turn but few tax consumers into taxpayers. The citizen taxpayer cannot complain of malfeasance or misfeasance if the language of the Act does not clearly instruct the officers of the state what they are expected to attempt or to accomplish.

This initial problem of intent can be met squarely on Federal and State levels. It is possible to write into the Federal Act and into the enabling acts of each state explicit statement of what the law and the appropriations are intended to accomplish.

The next basic problem encountered is that of administrative method. Within what framework shall the executive agency be established and how shall maximum performance be assured? Federal administration was originally assigned to the U. S. Office of Education, which was at that time in the Department of the Interior. In the states, with a few exceptions, executive responsibility was allotted to a board of vocational education. Some of the results of these allocations have provoked widespread criticism and dissatisfaction. Allocation is clearly another major legislative problem.

Problems encountered in vocational rehabilitation have involved far more elements than are found elsewhere in the field of vocational education. Accordingly, on the Federal level, the rehabilitation personnel has dealt with facts and conditions concerning which colleagues and official superiors in the Office of Education could give little aid or understanding. Situations, in dealing with evasive state politicians, which called for prompt and vigorous corrective action have been tolerated indefinitely because of the reluctance of administrative officials who held veto power without knowledge of operating problems. In one state, the initiation of rehabilitation was

obstructed for a decade by the tactics of a minor official. In another, a two-year delay in filling a vital administrative post had no effect upon the flow of Federal funds.

Within the states, rehabilitation has been effectively smothered, in many areas, because its budget, its payroll, its policies, have been subject to the veto of some vocational educator more concerned with his own special subjects than with special service for deviates. Effective service, on the other hand, has followed in direct ratio to the extent to which the Director of Vocational Rehabilitation can deal directly with the Commissioner of Education and the board of vocational education. The need for direct and undiluted authority is intrinsic in the total problem of rehabilitation.

Another phase of rehabilitation method which presents an obstinate problem is that of financing. The congress has selected a method of matching state appropriations with Federal funds from the reservoir of social security. By 1942, the annual sum available for this purpose was $3,500,000, which allowed a minimum of $20,000 per state. Thus, from Federal sources, much more money has been appropriated than has been applied by the states.

The President's Budget Commitee has held down the appropriations for the operations of the Federal Bureau to a degree which has seriously limited research, supervision and dissemination of information by such a bureau to a level which has been as low quantitatively as it has been high qualitatively.

At the state levels, some legislatures have left unused more than half of the available Federal funds and, as if this were not enough, economy committees acting for the Governors have contravened the intentions of the legislatures by cutting still further the operating funds of the state vocational rehabilitation bureaus. How can these interferences with the administration of rehabilitation legislation be prevented? What provisions can safeguard legislative enactment against executive meddling? By what means can the utilization of available Federal funds be stimulated at the state levels?

Previous legislation has offered, in the form of matching funds, a sort of award to those states which appropriate moneys for voca-

tional rehabilitation, but the Rehabilitation Act of 1920 and amendments fail to penalize inadequate appropriations by the states, or negligence in the administration of vocational rehabilitation such as those noted in a previous paragraph. Clearly then, a part of the problem in appropriation is not only to aid those states which respond to the intent of the legislation, but also to sting into compliance those which are laggard in appropriation or performance. If, for example, a state which left its rehabilitation bureau for two years without directive head or policy were summarily deprived of Federal funds, neither this nor other forms of negligence would continue to obstruct adequate service for the disabled.

The next problem encountered in rehabilitation legislation is one of limitation of media. If the health or the safety or the education of our population depended on official agencies alone, we should be at least a century further behind in our social development. Shall rehabilitation be treated as a monopoly of the Federal and state bureaus? Throughout many of the United States there have grown up in the last quarter century, voluntary health and welfare organizations, some on a national, some on a statewide, and some on a local scale, which have concerned themselves with the diagnosis, treatment and economic reestablishment of special groups of persons, many of whom are disabled by accident or illness. The ranks of their personnel include administrators, physicians, nurses, occupational therapists, physiotherapists, social workers, teachers, counselors, psychologists and other experts in special fields. The combined annual expenditure for aiding disabled persons exceeds that of most single states for similar purposes. Shall this reservoir of experience, facilities and personnel be utilized in accomplishing rehabilitation? Or is it expected that the official agencies shall accomplish by themselves the multifarious details involved in most successful service?

The pattern which has been followed pursuant to earlier rehabilitation legislation has depended considerably upon the resourcefulness and imagination of the administrator and supervisor. In some areas, the rehabilitation officials have utilized unofficial resources

as far as the law and the regulations have permitted them so to do. In other areas, the official activites have worn a deep channel of vocational training and have often actually and overtly resented the interest of non-official agencies in their clients. Occasionally, advisory boards and committees have been set up by the official agency, but their advice has not always been courted save as a piece of window-dressing and, in more than a few instances, the committees have never met. As a result, we have had some public agencies operating in a vacuum, while private agencies, despairing of any satisfactory response from the officials, have privately financed their own concept of effective rehabilitation service. Legislation, therefore, at Federal or state level, which does not provide definite and affirmative means for utilization of other than official resources, falls short of its opportunities.

In fact, previous legislation has not even made the most of collateral official agencies. For example: The terms of the Wagner-Peyser Act include provisions which enable cooperative personalities in the State Employment Services and the State Vocational Rehabilitaiton Services to work together toward a common end. It did not accomplish the intent of this provision because it lacked mandatory character to insure the teamwork, however reluctant, of contentious, narrow or inconsiderate personalities in either official organization. Much of the personnel in both these services, for some years, looked askance also on all workers in state or local public welfare organizations. As a result, many rehabilitation possibilities have gone on the rocks for want of adequate maintenance during proposed periods of training. No legislation is likely to meet the entire situation which does not canalize the information and service possible from all three of these agencies for the benefit of the handicapped person.

A further problem which should be weighed in the drafting and enforcement of rehabilitation legislation is an appropriate delimitation of persons. One of the first moves of any competent administrator is to emphasize the boundaries set upon his clientele by the enabling legislation. Accordingly, legislation should anticipate such

interpretation and make it clear who is and who is not to be included within such boundaries. By writing of the "physically disabled," those who drafted earlier rehabilitation legislation have placed a drastic legal barrier against all persons who are disabled by a history of mental illness and who need, chiefly, training and suitable employment like that of the physically handicapped in order to achieve permanent stability. We refer here first to those persons who, because of shock, sequela of other illnesses or from other physical or emotional causes, are faced with problems of social or occupational readjustment with which they have an innate capacity to cope when given adequate assistance. In view of the fact that the United States has more beds for mental illness than for any type of physical disability, the omission of this group is a profoundly tragic oversight. Even the mentally deficient group contains human salvage material. With suitable training and direction many a high grade moron may become useful manpower instead of an idle and burdensome pauper.

A number of the states have limited rehabilitation service solely to the destitute. Sound economy would, of course, provide that persons able to meet their own tuition or maintenance should do so. However, if the expert service represented in counseling, direction of training, and placement are to be avaialble to all disabled persons, this area should be made clear in the language of the Act.

Again, the application of the law has been delimited by regulation to "feasible" candidates. The tendency to adopt such a policy has come from early experiences in which medically naive or sentimental agents have given training to persons who died of their illnesses during the training period or while their applications were pending. From an initial naiveté, many of these policies have veered to a point wherein representatives of state vocational rehabilitation service have been unwilling to assume any hazard whatever. Complaint is made by medical and social agencies that many state rehabilitation officers limit their service to vocational training for clients who present virtually no problem of actual rehabilitation, but only one of vocational education. Unfortunately, no channel of

review has been provided by which the decision of an agent or his supervisor may be amended or revised by persons expert in the problems involved. The net result is a mutual irritability and distrust between some agencies interested in the client and some vocational rehabilitation supervisors. A complete legislative program must provide the means by which a taxpayer will be protected from sentimental and unwise selection on the one hand, and from a fatuous and arbitrary exclusion of all risks on the other. Much will be gained by providing means to assure all concerned that complete consideration has been given to this factor in reviewing individual rulings.

Many case workers in vocational rehabilitation have complained, and with reason, that most of their proposed clients were ill-prepared for vocational rehabilitation by those who served them during the processes of physical restoration. Previous legislation has given them minimal opportunity to work with clients still within hospitals, even to the extent of indicating a thread of continuity between occupational therapy, social service, and other treatment facilities within institutions and preceding post-hospital service.

Experience has indicated that it is necessary to prohibit the erection of institutions by the Federal or state rehabilitation agencies; but some time has been lost by failing to authorize maximum utilization of the institutions which are operated by the states, counties or by voluntary agencies.

Stability also is a central problem of rehabilitation legislation. By what means shall we establish stability of the agencies, stability of financial resources, stability of policy, stability of personnel and tenure, future stability of the client and, not least of all, stability of job objectives? Unless both Federal funds and state appropriations receive specific protection from budget trimmers, policy must often be cut to fit the cash which remains available. Unless the personnel on both Federal and state payrolls are protected by specific provisions against party patronage, continuous change of personnel will preclude effective continuity of policy. In the war emergency many agents and supervisors, weary of obscurity and

obstruction, have scrapped careful selection of job objective in favor of recognition for supplying manpower. The jobs are often blind alleys which at the armistice will end against a dead wall of technological obsolescence. Training of ephemeral value has been substituted all too frequently for that which may provide permanent stability for the trainee. That legislation is most effective which provides balances against opportunism and expediency.

Finally, the continuous problem of rehabilitation legislation has been a bureaucratic trend. This term is employed with no intent toward epithet. The rehabilitation supervisor is given a monopoly of power which, by its nature, provokes criticism of the manner in which it is administered. A strong personality learns from such criticism; a weaker one takes refuge in an arbitrary official despotism. Power to make decisions of final purport and effect in the lives of others should always be subject to review, at least on appeal, by persons familiar with the disabilities involved. Every official employed is under a continuous pressure from various vigorous influences in the state capitols to produce impressive statistics at whatever cost. In the field of rehabilitation, this pressure leads inevitably toward limitation of service. By service for only those who present fewest hazards, the greatest number of successful terminations can be recorded. The supervisor who is willing to select cases with greater recognition for need, hazards his own status unless he is backed by an advisory board more interested in the clients than in the statistics.

Most of the improvement in rehabilitation legislation, thus far, has been inspired chiefly by employees of Federal and State Vocational Rehabilitation Bureaus. Probably, we have reached a time when further improvement may come also from others not employed in any official capacity. One obstacle to such a contribution is the fact that in most areas, published reporting on rehabilitation is so limited that few persons outside official ranks have access to it. Accordingly, another essential problem of rehabilitation legislation is specific and adequate provision for publication of information and reports. The valuable reports of the Federal bureau are still

mimeographed, — seldom printed. Few of the states report to their taxpayers on the application of rehabilitation expenditures. Thus far, most of the printed matter issued, whether at Federal or state levels, has been aimed at employers who resist the employment of physically handicapped persons.

The problems reviewed thus far are intrinsic in our society. They arise from the number and characteristics of the disabled, and the agencies by which they may be served effectively. They take account of strong currents of dislike for deviates in the minds of many otherwise estimable educational administrators. The comments made are based chiefly upon observation of the workings, for better or for worse, of existing agencies and existing service.

As this book goes to press, 78th Congress struggles with rehabilitation legislation somewhat more thoughtfully conceived than that in the preceding session. It appears highly probable that adequate provision will be made for the rehabilitation of men disabled in the military service. One problem still in suspension is whether this may be done at the expense of civilian disabled who have often sustained their injuries while doing their allotted part in the total war effort. The opportunities for improvement are by no means ended when the Congress has decided upon national policy regarding both soldier and civilian rehabilitation. The construction of State legislation to take advantage of the new Federal provisions will afford opportunity further to expand and to improve reclamation of the handicapped, State by State, community by community. If this is left to run a routine course through the legislative mill we can expect little if any advance upon present practices. On the other hand, where and when medical, social and other voluntary groups concern themselves with the problem sufficiently to give evidence of the public interest it holds, local progress may be notably enhanced.

COMPENSATION FOR INJURIES

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Compensation — the balance or counteraction of opposed forces — is a law of nature. In one of the most comforting and inspiring of his essays, Emerson assures us that:

> * * * the compensations of calamity are made apparent to the understanding also, after long intervals of time. A fever, a mutilation, a cruel disappointment, a loss of wealth, or loss of friends, seems at the moment unpaid loss, and unpayable. But the sure years reveal the deep remedial force that underlies all facts.

The mention of a "mutilation" is significant, since it implies recognition by the laity of what the physician daily observes — the reparative powers of an organism, the *vis medicatrix naturae,* as it has long been called. It is my purpose to consider certain of the operations of this force, as related to a monetary benefit administered by the Veterans' Administration; viz., awards of "compensation" for disability adjudicated as attributable to military or naval service.

Here we note the term "compensation" in another connotation, and it might be interesting to trace the origin of that term as used in the laws governing the operations of the Veterans' Administration. The word "compensation" came into use in the act of October 6, 1917 (Public, No. 90, 65th Cong.), amending the act that authorized establishment of a Bureau of War Risk Insurance. Article III of that amendatory act provided for "compensation for death or disability." The term "pension" which it so displaced, had acquired disrepute because of scandals in the grant of pensions during the years following the Civil War. Besides, the designation "compensation" was thought better to comport with the new, rounded, symmetrical program of benefits provided under that act of October 6, 1917 (allotments and allowances, hospitalization, and medical

treatment, insurance, and vocational rehabilitation — under a separate statute). Compensation — the Government's acknowledgment of obligation to its defenders — was to be granted for disability that caused them reduction in earning capacity. The novel legislation so intelligently devised in the aforesaid act of October 6, 1917, reflected the principles and practices of workmen's compensation acts (which were at the time in effect in several of the more progressive States and were being proposed in other States of the country), rather than the traditional outworn "pension" system.

While determinations of "service connection" of a condition, the degree of disability from it (measured as average impairment of earning capacity), and the amount of monthly payment to be awarded, are responsibilities of rating boards and the appellate agency in central office, the physicians of the Veterans' Administration have an important share in the administration of disability compensation benefits. For the adjudication functions just mentioned are based upon reports of physical examination of claimants and beneficiaries; and the relative accuracy and fulness of such reports condition the deliberations of the adjudication units. Study of and compliance with the instructions in the Manual For Medical Examiners (which, in the paragraph, page 1, under "General instructions," defines succinctly the "Essentials of a physical examination report) should make it possible for the examining physician to discharge with satisfaction his duty in this matter.

In his work the medical examiner should, too, keep in mind the natural tendency of the animal body toward self-repair; its anatomical, physiological, and psychological adjustments to injuries. For the extent to which such adjustment or "compensation" carries will determine that degree of impairment of function — "disability" — which may be expected to persist as a residual of the injury. The term "injury," it is understood, is not used here in the restricted sense of trauma, but also comprehends damage to body parts and functions from disease. A particularly striking manifestation of the rallying power of the natural body forces is seen in the heart that "compensates" against valvular insufficiency. The extent which that

stabilization or adjustment attains is reflected in corresponding improvement of the symptoms — dyspnea, edema, cyanosis — which are the "disability."

In detailing the physical findings and symptoms he elicits, the examining physician should have thought of the degree of compensation attained; i.e., the adjustment and adaptability of the part in terms of partial or complete restoration of damaged function.

The capability of the human organism to repair damage is remarkable, and reestablishment of form and functions of an injured part follows to a degree frequently beyond expectations. The most elaborate treatment can only assist this natural process. As Ambroise Paré was wont to say in concluding his case reports: "I dressed him and God healed him." These spontaneous healing processes are primary, and their effects are proportioned to the presented needs. But they permit of speculative consideration.

Symmetrical duplication of tissues and organs is of fundamental importance. Through this provision, the body may withstand the impairment or loss of any one of a number of organs, provided the contralateral organ or member is in a reasonably healthy condition. After recovery from the initial shock, the loss may be more potential than real. This duplication of tissues and associated functions represents a safety factor of more than double the usual requirements. The loss of an organ reduces or eliminates the margin of safety from further use in case of emergency. Otherwise, after immediate recovery, the disability may be of a mild degree or even nil. In the event of involvement of a solitary organ or an essentially vital tissue, the outcome is necessarily much more serious.

The initial shock from injuries is borne principally by the neurocirculatory system. Complementary reactions are then brought into play to relieve the loss thus occasioned. One cannot study modern physiological opinion without realizing the intricate changes and interchanges which constantly act and counteract to balance and check reflex circulatory, respiratory, nutritional, secretory, and excretory functions in health and disease. The associated reactions continually compensate the body for the environmental and internal

vicissitudes of life. The response entailed by reason of injury effects this compensation for the damages sustained only insofar as the repair phenomena and substitute functions are adequate. This degree of recovery and adjustment should be accurately determined.

Progress toward recovery usually advances through the various stages of inflammation, with or without fever, immunity, and ultimate repair. The process is considered reversible up to the stage of cloudy swelling. Beyond this point, repair may be incomplete, complete or excessive. It is usually self-limited except where the competitive cellular growth, bacterial or neoplastic, is progressive; or where the organic defects, especially constricting and obstructing lesions, are insurmountable.

Duration determines these processes as acute, subacute or chronic. Healing develops from the original inflammation by cellular repair, vascular reconstruction, hyperplasia, and consequent hypertrophy of the remaining tissues having the same or similar functions. This is most effective where the injury is slight, of short duration and not soon repeated. It is a fundamental concept that repairs conform to the original pattern as closely as possible. It is also well known that the most primitive cells show the greatest ability to regenerate. The correlation of the mechanisms controlling these processes has been the subject of more recent studies. Catabolic changes are followed by a rest period before anabolic alterations are accomplished. Hemorrhage is followed by clotting, clot retraction, cellular migration, branching, budding, and division to fill the defect with a patch tissue. This contracts as a scar, and the hyperplasia of the parenchymatous cells proceeds. Local hypertrophy may result from this hyperplasia, as in polypi, keratoses, condylomata, exostoses, keloids, calluses, elephantiasis, adenomatous nodules, etc. These are the results of excessive repair and are more often observed where the exciting factors continue to operate over a prolonged period of time. Local repairs are usually associated with remote adjustments, and these are most important in the degree to which they approach the complete restoration of healthy function and activity.

Physiological studies offer theoretical explanations for the remote

changes which occur. One such theory is that the functional stimuli and sustained demand of the body remain unchanged although the amount of tissue involved is reduced. These stimuli are conveyed by nervous influences or hormonal substances to the remaining cells of a similar type. These cells then undergo enlargement, increased activity and division, as the case may be. The chemical and histological effects of various diseases on the several tissues of the body are well described in texts on special pathology. Generally speaking, the remote compensatory hyperplasia and hypertrophy tend to overcome the loss or atrophy of the injured part.

Particular instances of such local and remote changes in various tissues and organs affected by any of the myriad of diseases to which flesh is heir is not within the scope of this paper. Suffice it then to mention but a few examples to emphasize the subject, viz:

1. Increased activity is particularly noticeable in the glandular structures of mucous and serous membranes and the skin, resulting in the production of catarrhal, leucorrheal or purulent discharges, sputum, etc.; accumulation of transudates and exudates in the pleural, peritoneal, meningeal, and joint cavities; hyperidrosis and seborrhea, respectively.

2. Individual or combined internal secretions from glands which are associated and controlled by the autonomic nervous system, with resultant effects which may be cumulative or antagonistic.

3. The reestablishment of association tracts within the central nervous system and the multiple overlapping reflex pathways of the peripheral nerves, protecting and compensating for injury here.

4. Alterations in rate, rhythm, volume, and force of the heart action, together with dilation and hypertrophy of its musculature, maintaining the embarrassed circulation.

5. Spontaneous pneumothorax and pleural effusions, splinting the injured lung. Pneumo-circulatory acceleration at the time and, possibly, later regeneration of new alveoli at times, accounting for complete recovery.

6. Assumption of certain hematopoietic functions by the liver

and bone-marrow following disease and impairment of the spleen and vice versa. Adenomatous hyperplasia of liver and splenic parenchyma in certain instances.

7. Regeneration of pancreatic island cells to a limited degree.

8. Compensatory dilatation of renal glomeruli over an extended period of time, with marked increase in the output of urinary fluids and solids per unit of functioning tissue; uraemia not threatening until almost all of the functioning nephrons are involved.

9. Slight compensatory changes in the sexual glands to balance, as well as check, related functions of the associated glands of internal secretion.

10. Muscular tissues undergoing the best example of any work hypertrophy and permitting the body to adjust itself to mechanical defects of the skeletal and smooth-muscle structures of the extremities and internal organs, respectively.

11. Arterioles, capillaries, and veins establishing collateral circulation to supply tissues distal to the occluded lumina of vessels; trombi becoming canalized.

12. Callus reinforcing the fragments of fractures and lines of stress within the cortex of such bones, redesigned to support new directions in weight bearing.

The mental hazards are not always so readily overcome by some patients. This is particularly true in those who have marked disfigurement, or who may develop a "cripple complex." The patient must compensate for these mental hazards, so as to readjust his plans and occupational skill to suit a new economic situation. This possibility hinges somewhat on his own character and determination, with such aid from others as may be constructive in regaining his social and industrial adaptation status. To furnish unnecessary aid and support to such a patient may lead to his permanent dependency and guarantee his failure as an individual. To rehabilitate him, therefore, is almost as important as the treatment of his physical disabilities.

Adequate treatment and reeducation are the best services which

we can render our patients in order to reestablish them with the least permanent residual disability. As Hilton has so well stated in his little book on Rest and Pain, rest is the essential therapy. On the principle of rest to the affected part, much of our treatment is based. Splinting, bandaging, diet, and sedatives come within this classification, as well as rest in bed. Recreation and change of environment have a similar effect on mentally ill patients. Such a therapeutic regimen will bring some measure of relief and not infrequently will result in the cure of an acute condition. Specific therapy is rather limited as few such remedies exist.

VASCULAR AND NEUROLOGIC LESIONS IN SURVIVORS OF SHIPWRECK

I. IMMERSION-FOOT SYNDROME FOLLOWING EXPOSURE TO COLD

By Commander JAMES C. WHITE (MC), U.S.N.R.

As a result of enemy submarine activity, many survivors of torpedoed vessels have been exposed to unusual physiologic conditions. These include cold air and water and, when rescue is long deferred, prolonged dependency of the legs, malnutrition and vitamin deficiency. Many of these men have required hospitalization in naval and marine hospitals. One of the commonest incapacitating lesions is painful swelling of the feet and lower legs. This condition has been called "immersion foot." It has been my privilege to study it in Scotland and along the western Atlantic seaboard from Nova Scotia to Virginia. A surprising feature is that painful swelling of the lower extremities may take place both after exposure to the cold of the North Atlantic winter and the warmth of the Gulf Stream in southern latitudes in April and May.

The purpose of this paper is to point out that in the true immersion-foot syndrome, which occurs after relatively brief exposure of the lower extremities to cold water, there is actual thermal injury to the skin and subcutaneous tissue; whereas in the survivors of prolonged exposure in southern waters this feature is not present, but the painful swelling of the dependent parts is caused by a systemic disturbance.

Clinical Observations

Immersion foot, caused by prolonged chilling just short of actual freezing, has not heretofore received adequate recognition, although it must have occurred after torpedoings in the last war and after shipwreck in northern waters since time immemorial. An excellent

clinical picture has recently been given by Webster, Woolhouse and Johnston,[1] the Canadian naval medical officers who have treated by far the largest number of cases. According to them:

> At the time of removal of the patients from the open boats or rafts, the feet were cold, swollen and waxy white in color, with scattered cyanotic areas. The patients complained at that time that their feet felt heavy, "woody" and numb, and the feet were anaesthetic to pain, touch and temperature.
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> Shortly after removal of the feet from this traumatizing environment, the swelling increased rapidly as the feet became red, hyperaemic and hot without sweating, and the pulse in the vessels of the feet was full and bounding. In those more severely damaged areas—usually the toes, the distal part of the dorsum of the foot and the ball of the foot—the parts remained oedematous and hot, and assumed a livid, cadaveric appearance. A number of these latter areas later produced blebs, some of which were filled with straw-colored fluid and others with extravasated blood; and areas of ecchymosis commonly appeared over the medial aspect of the first metatarsophalangeal joint and on the medial aspect of the longitudinal tarsal arch. Many of these feet presented the appearance of incipient massive gangrene. The rapid swelling and increasing redness, accompanied by the extreme rise in temperature of the part, presented the picture of an intense vasodilatation, accompanied by definite damage to the vascular wall with transudation, as manifested by bleb formation and extravasation of blood.
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> The anaesthesia followed a variety of patterns. In the mildest cases these areas extended around the margins of the foot and over its plantar aspect, being of greater extent along the lateral border, where the mass-to-surface ratio is smallest. In the more severe cases these areas extended over the entire dorsum of the foot, and in some cases over the lower two thirds of the leg. Patches of anaesthesia over the knees in the prepatellar and infrapatellar regions were observed in two cases where there had been prolonged kneeling in the lifeboats.

Attention was first focused on this syndrome by the Medical Corps of the Royal Navy after the loss of a ship off the northern Norwegian coast in the late spring of 1941. The ocean temperature was around 40° F. A number of the crew were adrift on Carley rafts for several days. These rafts are large, doughnut-shaped floats with an open lattice in the center. The occupants are therefore forced to sit on the floating outer hull and keep their feet immersed in the cold water that washes in and out of the bottom. After these survivors were rescued by trawlers (which carry no medical officers), the mistake was made of rapidly warming their numb and swollen

feet before the galley stove. Three months later, when I visited the naval hospital at which they had been treated, the last of these patients was being discharged. From the description given me by Surgeon Rear Admiral Sir William Wheeler and from the recently published account by Ungley,[2] the vascular and neurologic changes in the immersed extremities were identical with those of the Halifax survivors that are described below, except for their greater severity. Owing to the unfortunate rapid warming before the galley stove, a number of these men developed gangrene, which necessitated amputation. The others suffered from trophic disturbances of the skin and neuritic pain, which prevented their return to active duty for a very protracted period. The severity of the process and the prolonged period of convalescence illustrate the need of efficient first-aid and subsequent hospital treatment.

During the past winter over 100 similar cases have been treated in Halifax. Through the kindness of Surgeon Commander D. W. Johnstone, the senior medical officer of the Canadian Navy there, I was given every facility to examine 32 survivors of three vessels torpedoed in the North Atlantic early in March, 1942. These patients were under the charge of Surgeon Lieutenant Commander D. R. Webster, Surgeon Lieutenant F. M. Woolhouse and Surgeon Lieutenant J. L. Johnston, who were extremely co-operative and helpful. A description of their cases has just been published by them.[1] The reason for presenting this brief résumé of their work is twofold: first, to add observations on 15 other cases seen at the Halifax Infirmary, with the senior surgeon, Dr. Alan Currie, at the Columbia Medical Center, with Dr. David Bull, and at the United States Naval Hospital in Chelsea; secondly, to contrast these cases of immersion in cold water with a series of superficially similar, but fundamentally quite different, results of more prolonged immersion in warm water seen at the United States Marine Hospital in Norfolk during May, 1942. The latter group will be taken up in the second part of this paper.

The 32 patients seen in Halifax were exposed to air and water close to freezing temperature in three lifeboats for periods ranging

from twenty-seven hours to four days. In all cases it had been impossible to keep the boats bailed dry, so that water was sloshing about over the floor boards from a depth of a few inches up to the height of the thwarts. The men's legs were therefore constantly wet below the knees and actually immersed most of the time from the ankles down in cold water. The reaction of the lower extremities to cold and wet was greatly aggravated by the fact that they were continually dependent and that, on account of crowding, there was no opportunity to exercise or elevate the legs (see below, section on "General Responses of Tissues to Cold"). Whether the survivors wore shoes or not made little difference, as the wet feet became so swollen that any boot soon became tight and constricting. The feet under these conditions rapidly became numb, painless and cadaveric in color. A few of the men tried at first to keep out of the water, but soon gave up. Only in the rare cases where men had on loosely fitting rubber hip boots and managed to keep their feet relatively dry, or where they were able to wrap them in a blanket and keep them clear of the water for the better part of the time, were they able entirely to avoid this condition.*

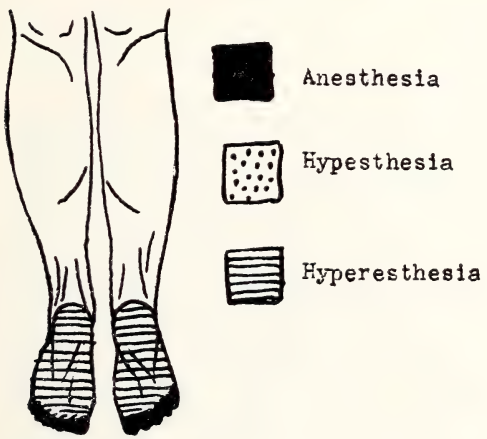
On being picked up by rescuing vessels, those who suffered from immersion foot observed that it felt as though they were "walking on air" or "on blocks of wood." The more severely afflicted men could not maintain their balance or walk, and had to be supported or carried. On arriving in warm quarters below decks, their feet were so swollen that if boots had been kept on they usually had to be cut off. The extreme swelling and gray, cyanotic hue of the severe cases made it look as though many might develop gangrene of the feet. Fortunately, the mistake made in the first-aid treatment of the British survivors reported above was not repeated here. None of these men had their numb feet soaked in hot water or warmed before a galley stove. Some had them immersed in cold water for a brief period, others rubbed with alcohol (even this was a mistake;

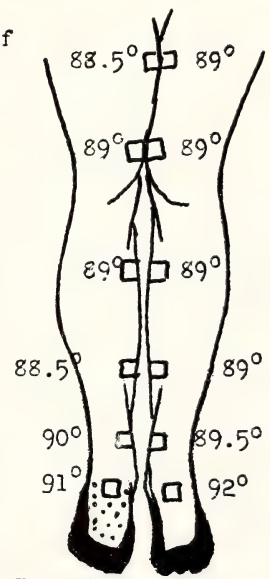
*Since this article was written I have had the opportunity of examining 8 members of the crew on a torpedoed merchantman after three days adrift in cold water. Three of these men had been protected by a new type of rubber lifesuit and suffered no thermal injuries, whereas the remainder, who wore ordinary clothes, all developed immersion foot of moderate severity.

see below, section on "Treatment"). They were then put in bunks and given hot drinks. In the milder cases the feet began to tingle and burn as soon as they warmed up, but those more severely chilled remained numb for much longer periods.

On reaching Halifax it was observed that the feet, which at the time of rescue had been cadaveric in color, cold and numb, were pink, hot and painful, as in erythromelalgia. The edematous skin was dotted with petechial hemorrhages and, in the severer cases,

Moderate hyperemia and anesthesia, without much cutaneous injury, 2 weeks after rescue.
Appearance of feet: Redness of skin and petechial hemorrhage Redness most striking in dependency. Very slight residual swelling. Superficial loss of epithelium on soles
Arteries: All pulsations strong
Veins: Very prominent
Sweating: Began slightly over skin of proximal feet at 13 days
Neuritis: +++, beginning to subside.





Sensation

Touch, vibration, and detection of figures present except in toes.
Two-point discrimination slightly reduced over dorsum of feet, absent in toes

	T_1	T_3	T_5
R.:	89°	88.5°	88.5°
L.:	89°	88.5°	89°

Room: 70.5°

FIG. 1. Case 10.

with large blisters that resembled those of a superficial burn. Sensation, which at first was absent above the ankle, usually descended to the midfoot within a period of twenty-four hours, although the toes often remained anesthetic for a period of several weeks (Fig. 1). With the partial return of sensation, burning, tingling pain became intense and, together with the risk of the blebs' rupturing and becoming infected, presented the major therapeutic problem. These clinical findings seen in the Halifax cases are summarized in Table 1 and illustrated in Figures 2 and 3.

Examination of Table 1 shows that of the 19 acute cases of true immersion foot examined in detail, only 2 developed areas of gangrene of sufficient depth to require surgery. In Case 19 bilateral major amputations were necessary, owing to the cellulitis that followed the prolonged severe exposure and was already present when the patient reached the hospital. The infection entered through the blisters that always develop after long immersion in cold water. In Case 1 the loss of tissue involved several of the small toes, and late infection secondary to epidermophytosis eventually necessitated their amputation. Eight patients showed edema, blebs,

FIG. 2. Case 1.

The photographs were taken on the twelfth day after rescue. The man had been in a lifeboat without shoes for four days in the North Atlantic in March. The temperature of the sea water was recorded at 34° F., and his feet had been wet most of the time. On arrival in Halifax the hyperemia and vascular engorgement of the lower legs were intense; his feet were greatly swollen, blistered and anesthetic; his toes were blue-black and gangrenous looking. After treatment by cooling for twelve days in ice-packs, the swelling was greatly reduced, the blebs had nearly absorbed, and the condition of the toes distinctly improved. Nerve recovery had not progressed far enough to cause pain.

petechiae and superficial patches of gangrene from their severe chilling (Cases 2, 3, 4, 6, 7, 8, 18 and 19). Thirteen men (including all the above and also Cases 5, 9, 10, 13 and 14) had profound circulatory disturbances with intense hyperemia. The intensity of the hyperemia seemed to correspond directly to the degree of sensory impairment. The inability of the hyperemic feet to sweat was also a very constant observation, and indicates that injury of the sympathetic fibers corresponded to that of the pain fibers. As these two sets of axones closely resemble each other in their diameter, degree of myelinization and rate of conduction, this is not surprising. It was also evident that patients who showed the most definite signs of nerve and tissue damage were generally the ones that developed the severest degrees of neuritic pain. Pain was a distressing symptom in 11 patients (Cases 2, 3, 4, 6, 7, 9, 10, 11, 12, 13 and 18), particularly in the first two weeks. At the end of this period the active inflammatory process was usually subsiding, and the skin of the sole and toes desquamating in large sheets. In cases with inadequate early treatment, both swelling and pain tended to persist and become a cause of prolonged disability (up to six months).

A number of late complications have been observed in consulta-

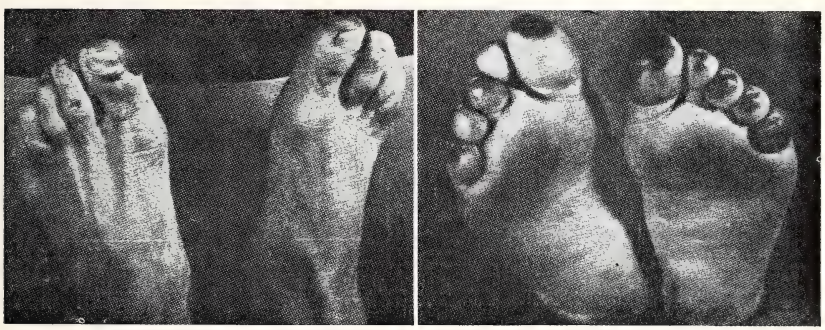


FIG. 3. Case 2.

This seaman was in the same lifeboat as the man whose feet are shown in Figure 2. He also had no shoes, but his local injury from cold was much less pronounced. He was able to walk, and on admission to the hospital his feet were only slightly swollen, with hypesthesia of toes and intense hyperemia. Pain was severe, but after ten days' treatment in ice-packs, circulation had returned to normal and the pain was no longer present so long as his feet were exposed to the cool air of the ward. The patches of gangrene shown in the photographs, taken on the twelfth day, were only skin deep.

tion with Drs. A. W. Stearns and R. S. Schwab at the United States Naval Hospital in Chelsea, and with Dr. D. C. Bull at the Columbia-Presbyterian Medical Center in New York City. These include atrophy of the intrinsic muscles in the feet (2 cases), a chronic sense of bursting fullness in the lower legs in patients who had varicose veins (3 cases) and various manifestations of psychoneurosis (8 cases). The latter are outside the scope of this paper.

General Responses of Tissues to Cold

Before discussing the important subject of treatment, it will serve to orient one's concepts in that regard to review what is already known about the fundamental responses of the tissues to cold and the pathologic changes that take place in them after severe chilling and ischemia. On reviewing the literature, one is struck by the fact that there is no fundamental clinical or pathological difference in the varied syndromes that follow exposure to cold. There is furthermore a striking similarity to injuries due to burns. Modern accounts begin with Baron Larrey's[3] experiences while serving as surgeon-general of Napoleon's army in the winter retreat from Moscow. In the Crimean War[4] it was observed that the soldiers suffered most in temperatures just above freezing in the wet mud and snow of the trenches, particularly when unable to move about. Even then it was recognized that fatigue, stagnation of circulation, constriction of the legs and scurvy were important accessory factors. Greene,[5] who as medical officer of two Himalayan expeditions had an unusually wide experience, has written a most timely account of the injuries that follow various forms of exposure to cold. He describes the trench-foot syndrome of the last war, which is essentially identical with that of immersion foot. Numbness gradually develops in cold, wet, dependent extremities, and is followed by swelling and blistering. When the blisters rupture, streptococcal infection may bring about widespread gangrene. This may occur in lifeboats as well as in the trenches, provided the exposure is prolonged enough for the blisters to break and become infected, as in Case 19. Pain in trench foot also is a distressing symptom. "Shelter

foot," first described in 1940 by Knight,[6] occurs in persons who spend nights in cold air-raid shelters without moving or elevating their legs. The condition is aggravated by constriction, as when the back of the calf has been compressed by the bar of a deck chair. These feet become red, shiny and painful. Increased capillary permeability from malnutrition (lowered serum protein and vitamin deficiency) are important accessory factors. Greene makes a brief reference to immersion foot, but states that he has never seen a case of it. The first comprehensive reports on this syndrome have been published recently.[1, 2] In addition, previous clinical and laboratory investigations are of value in understanding the underlying features of the condition.

The effects of cold with special reference to frostbite were studied by Rischpler[7] in 1900. He froze animal tissues by the application of ice and salt, and investigated the results microscopically at various intervals. Under these circumstances actual degeneration was found in the cells of the blood-vessel walls, with swelling of the connective tissue and vacuolation of the smooth-muscle fibers, but there was no sign of thrombosis. During the last war Lake[8] found that the critical temperature where all metabolic processes are inhibited is –6° C. (21° F.). He claims that at this temperature blood freezes with destruction of cells, liberating thrombokinase, and that on thawing thrombosis occurs. More recent studies by Lewis[9] show that this is not necessarily true. Although the freezing point of blood is –0.53° C., and that of the tissues close to this level, Lewis found that skin when cold rarely freezes at its true freezing point. It exhibits the property of supercooling and may not freeze until the temperature falls to much lower levels, –20° C. (–4° F.). As the freezing point of sea water itself is –1.9° C., it is obvious that, in immersion foot, actual freezing does not take place.

In investigating trench foot in the last war, Smith, Ritchie and Dawson[10] carried out an admirable set of animal experiments under conditions that closely resemble those resulting in immersion foot. They subjected rabbits in a cold chamber to standing on wet mud. When this was continued for three days, especially after removing

TABLE 1. Summary of Findings in Cases of Immersion-Foot Syndrome (Northern Survivors).

Case No.	Tissue Damage on Arrival at Halifax	First Sensation	Pain Severity	Duration	Sensory Loss	Sweating	Hyperemia	Treatment	
								Type	Duration
1	Swelling and blebs + + ; gangrene of several toes.	Still absent	?	?	Distal half of feet	Absent below ankles	+ + +	Continuous ice packs Later, amputation of several toes	12 days
2	Swelling and blebs + ; patches of cutaneous gangrene.	4 days	+ +	Subsiding	Toes	Normal	+ + + (10 days)	Continuous ice packs Exposure to air	10 days 2 days
3	Swelling and blebs + + ; small petechiae.	5 days	+ + +	Beginning to subside	Distal third of feet	Absent below ankles	+ + +	Intermittent ice, air and electric fan	12 days
4	Swelling and blebs + ; petechiae.	—	+ +	Beginning to subside	Toes	Absent lower feet and toes	+ + +	Intermittent ice, air and electric fan	12 days
5	Slight	—	+	Beginning to subside	Toes	Absent lower feet and toes	+ + +	Exposure to air	12 days
6	Swelling and blebs +	2 days	+ +	Still present	Toes (hypesthesia)	Absent lower feet and toes	+ + + → +	Continuous ice packs	12 days
7	Swelling and blebs +	1 day	+ +	Still present	Toes (hypesthesia)	Normal	0	Exposure to air	12 days
8	Swelling and blebs +	1 day	+ + → +	Subsiding	Almost gone	Normal	+	Exposure to air	12 days
9	Swelling +	3 days	+ +	Still present	Almost gone	Absent lower feet and toes	+ + + → +	Continuous ice packs Exposure to air	13 days 1 day

TABLE 1. Summary of Findings in Cases of Immersion-Foot Syndrome (Northern Survivors).
(*Continued*)

CASE NO.	TISSUE DAMAGE ON ARRIVAL AT HALIFAX	FIRST SENSATION	PAIN		SENSORY LOSS	SWEATING	HYPEREMIA	TREATMENT	
			SEVERITY	DURATION				TYPE	DURATION
10	Swelling +	10 days	+ + +	Increasing	Distal third of feet	Normal	+ + +	Exposure to air Intermittent ice packs	12 days 2 days
11	Slight	1 day	+ +	Subsiding	Toes (hypesthesia)	Normal	0	Exposure to air	12 days
12	Slight	12 hours	+ → + +	Still present	Toes (hypesthesia)	Increased	0	Exposure to air	12 days
13	Slight	1 day	+ → + +	Increasing	Toes (hypesthesia)	Normal	+	Continuous ice packs Exposure and elevation	3 days 10 days
14	Slight	3 days	?	?	Distal third of feet	Normal	+ + +	Continuous ice packs (right), exposure to air (left)	1 day
15	Slight	6 hours	+	?	Feet (patchy areas of hypesthesia)	Normal	0	Exposure to air	1 day
16	Slight	Never lost	Slight	?	0	Normal	0	Exposure to air	1 day
17	Slight	Never lost	Slight	?	0	Normal	0	Exposure to air	1 day
18	Swelling and blebs + ; petechiae.	12 hours	+ + +	Still present	Distal half of feet	Absent below ankles	+ + +	Intermittent ice packs Exposure to air	14 days 1 day
19*	Cellulitis and septic gangrene of feet.	—	—	—	—	—	—	Early amputations	

*Patient seen four months after rescue; reaction to immersion altered by infectious gangrene, which came on during thirteen days' exposure.

the fur from the paws, marked swelling of the feet resulted. Histologic examination showed changes in the blood-vessel walls, with an outpouring of fluid containing both cells and fibrin. Occasionally the nerve trunks showed diffuse swelling of the axis cylinders, but without evidence of degenerating fibers in preparations stained by the Marchi method. The investigations thus proved that simple prolonged exposure to cold can produce subacute inflammation of the skin and subcutaneous tissues of the feet. These changes could be exaggerated by moisture, by applying constricting bands to the upper legs and by rapidly warming the chilled extremities before the animals were sacrificed.

The most illuminating discussion of the pathologic physiology of tissues exposed to cold is contained in a series of three lectures delivered by Sir Thomas Lewis[9, 11] in 1941. On exposure to cold the blood vessels are constricted both by vasoconstrictor impulses from the hypothalamus and by direct contraction of the smooth-muscle cells in their walls. But when the temperature of the skin drops near to freezing, there is an intermittent increase in blood flow, which serves to maintain the viability of the skin. This phenomenon is carried out by a special mechanism of arteriovenous anastomoses (Grant and Bland[12]) and is mediated by local axone reflexes. How long this mechanism can maintain its efficiency in the cold is not known, and it seems probable that the circulation must be reduced to a low point. Lewis observed that immersion of the normal hand or foot in water at 5° C. (41° F.) for as short a period as two hours resulted in definite swelling. This swelling, which may amount to as much as a 15 per cent increase in volume, is not the simple result of imbibition of water by the skin, since it happens in a hand protected by grease or covered by a rubber glove. If swelling of this degree can occur after a few hours, it is obvious that large amounts of fluid must be lost from the circulation on prolonged general exposure. The reduction in the circulating blood volume is the cause of the somnolence and death that overtake so many seamen in lifeboats during severe winter weather. Lewis considers this response to cold to be caused by an "H,"

histamine-like substance released from the injured cells and acting on the blood vessels.

When the chilled extremity is removed from ice water, the invariable response is a state of hyperemia. The local reddening, vasodilatation and extravasation of fluid from the injured vascular bed are all part of Lewis's classic "triple response." The wheal which first forms may be replaced by a blister. These changes together constitute a simple acute inflammation. Sections of human skin examined by Lewis twenty-four hours after chilling displayed edema of both epidermis and dermis, and a perivascular infiltration of the superficial layers of the dermis with lymphocytes, extravasated red blood cells and some polymorphonuclear leukocytes. Observations now completed in Halifax on many cases of immersion foot show that this inflammatory hyperemia reaches its height on about the third day after the period of exposure is ended and gradually disappears in the course of a fortnight, much as occurs in any other sterile inflammatory reaction.

The changes that occur in the nerve trunks and the terminal superficial axones to the skin are a second point of particular interest. These patients at first have complete cutaneous anesthesia below the ankles. In the mild cases this clears rapidly on warming, but in the severe ones there is still anesthesia of the toes at the end of a fortnight and reduced sensation over the remainder of the foot. The speed at which sensory recovery may take place over the dorsum of the foot is too great for nerve regeneration and is evidence that the majority of nerve fibers never actually degenerate. This fits in with Smith, Ritchie and Dawson's[10] observations in rabbits' feet after seventy-two hours' exposure to cold. They found definite swelling of the axones, but no evidence of their degeneration. However, in some of the patients of this series (Cases 1, 3 and 10) the toes were still anesthetic at the end of a fortnight and there was little sweating below the ankle. This suggests actual degeneration of the sensory and sympathetic axones to the more exposed distal portions of the feet, which may require a period of several months for complete regeneration and restoration of normal

function. In Ungley's[2] recent report on the Scottish cases, Wallerian degeneration of some of the cutaneous nerves was observed by Blackwood, who examined the biopsies. It is a well-known fact that a partially injured nerve is likely to produce a painful neuritis, and this has been the universal experience in the severe cases of immersion foot. Accurate objective determinations of the recovery of nerves can be made by testing the return of sweating by the method recently described by Minor[13] and by Guttmann[14] at Oxford, and the changes in electrical skin resistance (Richter and Woodruff[15]). These methods wil be utilized when suitable patients are available in Boston.

The fact that patients continue to suffer after their circulation has returned to normal suggests that the pain is neuritic in origin. This is the most logical explanation in the late stages, but during the acute phase of the reaction this may not be the entire reason. In this connection it is of interest to quote the impression of Webster and his colleagues[1] that these men are comfortable when their foot temperature is kept below 80° F., but that as soon as the ice packs are left off and the cutaneous temperature of the toes is allowed to exceed 90° F. they again experience pain. This fits in with the observations made by Freeman[16] on legs with threatened gangrene. By plethysmographic studies of blood flow in sympathectomized extremities, he has demonstrated that a rise with local heating is caused solely by the increased metabolism of the tissue cells and their need for more blood and oxygen. Local cellular metabolism, like other chemical reactions, should double or treble the consumption of oxygen for each 20° F. rise in tissue temperature. This chemical vasodilatation is not active at temperatures below 85° F., but increases rapidly at higher levels. As a result, if the supply of blood to the tissues is not correspondingly increased, the cells must suffer oxygen want and this is invariably a cause of pain. Whereas the blood flow through the main pedal vessels is increased tremendously during the phase of acute hyperemia, there is good evidence that the cutaneous arterioles and capillaries have been injured and that therefore there may be a disparity between the supply and the

demand for oxygen on the part of the tissue cells surrounding the cutaneous network of sensory nerve endings. On these physiologic grounds moderate cooling of the skin that is involved in a sterile inflammatory process will reduce the metabolic demand for oxygen. If demand can be made commensurate with supply, pain will be alleviated. Lewis[17] stated that spontaneous pain occurs in skin rendered hyperalgesic by heat and other types of injury, and that it is enhanced by warming and relieved or abolished by cooling. Both these factors constitute strong arguments for therapeutic cooling of hyperemic painful feet during the early stage of the post-immersion reaction. Actual experience has borne this out, as it has been found that reducing the cutaneous temperature to 80° F. gives consistent relief in the acute stage.

From a consideration of the above facts concerning the reaction of the tissues to cold, it becomes evident that the common denominator in all conditions that follow thermal insults is injury to the blood vessels and nerves. As Lake[8] pointed out, "a vicious circle is set up, for the greater the exudation the greater the venous obstruction, and the greater the venous obstruction the greater the rise in capillary pressure, and hence the greater the exudation."

Treatment

PROPHYLAXIS. — All ship's officers and seamen should be acquainted with the dangers of exposure to cold air and water. When there is sufficient time before abandoning ship, all hands should get into the most waterproof and loosely fitting boots they can obtain and take along extra pairs of heavy socks. If waterproof boots ship water and are wet inside, much can be accomplished by emptying them out periodically and putting on another pair of socks. This is the case even when the socks have been previously wet, provided they are wrung out and partially dried. Much can be done to prevent frostbite of the hands and feet by greasing the skin. Lewis[9] pointed out that the property of "supercooling" is abolished by wetting and washing the skin, but is greatly enhanced by greasing. A further point to remember is that men in crowded lifeboats must remain

fairly immobile, with their legs dependent. Movement of the cold, benumbed extremities, even temporary elevation, and avoidance of constricting pressure on the legs from clothing or boat gear are helpful factors in preventing severe injury.

FIRST-AID — When shipwrecked survivors are picked up after prolonged exposure to wet and cold, they should be lifted aboard the rescuing vessel and carried below if their feet are numb, in order to prevent further injury to the anesthetic skin. The possibility of a severe reactive hyperemia and subsequent neuritic pain in the feet must be anticipated, even if actual gangrene from freezing has been avoided. These men require treatment for general as well as local chilling. Methods for dealing with the former are simple and well established, but while external and internal heat is being applied as a first-aid measure to the body as a whole, it should be borne in mind that the chilled extremities will suffer if they are warmed with equal rapidity. It is vitally important, therefore, to warm the patient as a whole first and prevent the chilled, bloodless extremity from increasing its metabolic demand for oxygen more rapidly than it can be supplied by a tardy restoration of the peripheral circulation. Although an appreciation of the risks of warming chilled extremities has been handed down as part of the folklore of the Eskimo, and the danger of this procedure was clearly understood by Larrey[3] over a century ago, it is not generally recognized by seamen today.

Whether a person has suffered actual freezing or the less severe chilling seen in immersion foot may not be at first apparent, but in either case the immediate local treatment is the same. It should consist in keeping the exposed extremity cool, elevated slightly above the level of the heart and surgically clean. There is no previous medical experience to point out the most effective methods of attaining these ends, and whatever methods are proposed here will undoubtedly be modified and improved. As local first-aid treatment on shipboard I suggest the following:

1. Give the skin of the feet a preliminary cleansing with soap and cool water. This is to remove superficial dirt and bacteria, which may cause

infection of the blisters and thus open the way to cellulitis and moist gangrene. Surgical cleanliness should be scrupulously maintained until the blebs are resorbed and the danger of infection is past. If the blisters have ruptured, do not apply any antiseptics. Dust these raw areas with sulfanilamide powder or cover with sulfathiazole ointment, but if neither is available leave them alone. On transferring these patients to a hospital ashore, the feet can best be protected against bacterial contamination from blankets and handling by covering them with a sterile towel or bandage (if available), or clean cotton socks.

2. Keep the feet cool by exposure to the room air. Have no bedclothes below the knees, the room cooled below 70° F., and, if possible, direct cool air from a blower or electric fan over the exposed feet and legs.

3. Avoid pressure points on the feet, especially the heels, and elevate the feet on a pillow. Under no circumstances permit these patients to sit up with their legs dependent, as this increases swelling. Elevate the legs so that the feet will be above the level of the heart and thereby promote drainage of edema fluid. Remember that anesthetic, swollen feet are vulnerable to trauma and infection. For this reason even gentle rubbing or massage is dangerous.

4. Use codeine or morphine as necessary to control pain.

HOSPITAL — On arrival in the hospital, the severe cases have pronounced swelling, blebs and discoloration. They have the greatest amount of anesthesia and, for the first few days, the least pain. Hyperemia is striking, with dilatation of the main arteries and prominent veins, but circulation through the cutaneous arterioles and capillaries is nevertheless inadequate, as shown by a dusky cyanotic color and minute hemorrhages in the skin. As explained above, the rationale of treatment at this stage is to reduce tissue metabolism to a point where there is an adequate supply of oxygen to all the cells. This can be accomplished by cooling the skin 5 to 10° F. — to a point below 85°*. Experience has already shown that, under these conditions, color improves, blebs tend to resorb, and edema is reduced.† In the mild cases this degree of

*Lake[8] deserves the credit for being the first to suggest treatment by continued cooling. In 1917 he wrote, "It would appear better to keep the limb cold by the application of wet cloths, until efficient treatment can be given, than to allow partial warming to occur." The Halifax experience has, however, demonstrated that wetting the skin is deleterious because it causes maceration.

†This is also true in an experimental burn. Drs. Oliver Cope and George Mixter, Jr.,[18] have shown that cooling the burned leg of a dog to 50° F. reduces edema to a striking degree, with a corresponding reduction in vascular extravasation and lymph production.

cooling can be brought about by simple exposure to room air, provided the ward temperature is kept below 70° F. Slightly greater chilling can be obtained by having an electric fan on a bedtable blow air over the feet (Fig. 4), and this can be renderd more effective still if the patient occasionally sprays water from an atomizer into the stream of air from the fan.

During the most intense stage of hot, congested feet, and also when the neuritic pains are severest, neither of the above measures is effective. The naval medical officers in Halifax have worked out a very satisfactory type of ice pack for use under these circumstances. This consists of a cotton hand towel to cover the foot; four ice bags applied over the dorsum, soles and sides of the foot; oil-silk wrappings to 12 cm. above the malleoli; a thick insulating pad of fluffed cotton or cellulose; and a rubber pillowcase tied loosely about the calf of the leg. The purpose of this pack is not to induce severe chilling, which might lead to further trophic disturbances, but to cool the skin of the foot and toes to a level between 80 and 85° F. During the early, intensely hyperemic stage a thermocouple inserted next to the skin shows that the temperature

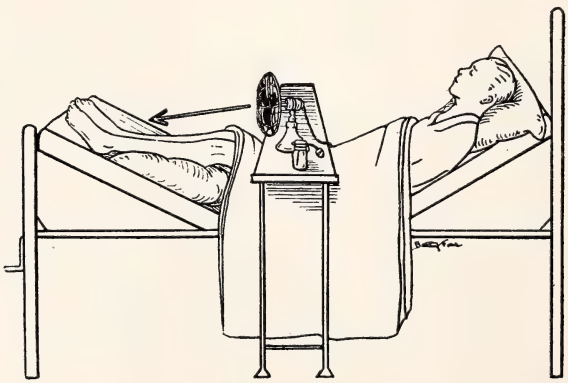


FIGURE 4. *Method of Cooling Feet by Exposure to Room Air Supplemented by Electric Fan.*

Note that the legs are elevated and that the heels are protected from pressure by a pillow under the calves. The injection of a fine spray of water into the revolving fan blades with an atomizer further increases the cooling.

of the foot does not fall below 90° F., although the toe temperatures may drop 5 to 10° farther. At this period the active circulation causes rapid melting of the ice. The packs should be changed at four-hour intervals and observations of skin temperature made at these times to control their application. In Case 2 the feet maintained this intense hyperemia in continuous ice packs for the first eleven days, but on the twelfth day of treatment they became distinctly cool. The ice packs were then discontinued and treatment by exposure to cool air begun.

From this point on the patient can usually be made comfortable by simple exposure of his legs from the knees down, supplemented if necessary by a breeze from an electric fan as mentioned above. At night, however, the neuritic pains may increase in intensity. The patients appreciate the value of the ice packs for relieving pain and often request their reapplication. Under these circumstances a less elaborate pack is usually sufficient, consisting of a cotton towel to cover the foot, two ice bags on the dorsal and plantar surfaces and a large bath-towel wrapping.

In carrying out treatment with ice packs it is important to make sure that they do not leak and wet the skin. Each time this has occurred it has caused sogginess and maceration.

In all the patients tested during the hyperemic stage, and even when it was subsiding, hanging the feet over the side of the bed caused striking congestion and pain. Conversely, elevation made the feet more comfortable. Many of the men discoverd this for themselves and elevated their legs at the time of painful crises. The elevation need not exceed 20°. This is the best position for patients who are being treated by simple exposure of the legs to cool air, with or without an electric fan (Fig. 4).

On a theoretical basis, I advocate a period of Buerger's exercises prior to getting the patients out of bed. In these exercises, which are so useful in cases of threatened gangrene from arterio-sclerosis or thromboangiitis obliterans, the feet are first hung over the side of the bed for four minutes, while the patient exercises the foot muscles by dorsiflexion and plantar flexion, inversion and eversion

at the ankle and then flexion and extension of the toes. The feet are next elevated 45° for one minute, and then rested flat on the bed for five minutes. Cycles of these exercises carried out for half-hour periods three to four times a day should be tried as soon as the patient can tolerate the dependent position, and continued conscientiously for a week before permitting him to get out of bed.

Another measure often helpful in the early stage of edema and neuritic pain, particularly after prolonged exposure with starvation, is a diet high in protein and vitamin B. This is of specific value in survivors who have been adrift for long periods on a deficient diet, as will be shown in the second part of this paper.

On the basis of the similarity between the swelling due to immersion in cold water and that secondary to a burn, Koch's[19] method of compression dressings might be a valuable adjunct in treating patients with particularly severe edema and bleb formation, provided hyperesthesia of the skin is not a major complication. I hope to have the opportunity to give it a trial this coming winter. However, in view of the fact that thermal injuries from cold often have associated cutaneous anesthesia, care will have to be used in applying a tight dressing, in order to avoid trophic ulceration.

Operations for Relief of Pain and Vasospasm — Smithwick and White[20] have advocated crushing the peripheral nerves through small incisions above the ankle for the relief of intractable pain in cases of peripheral vascular disease. This operation has been extensively employed during the past twelve years and has proved valuable. When the nerves regenerate, as they do regularly in three months, they do so without pain. Such a procedure should also be of value in the control of the neuritic pain of immersion foot, provided cases occur with such severity that the methods given above prove inadequate. To test this out I injected the posterior tibial and the superficial and deep peroneal nerves in Case 10 with a 2 per cent solution of procaine and found that the patient obtained complete relief for a period of two hours. Nerve crushing should be reserved for the severe cases, as it will incapacitate the subject

for duty for three months, the period required for full regeneration of the nerves.

Blocking the sympathetic outflow to the lower extremities by therapeutic paravertebral injections of procaine hydrochloride and by lumbar sympathectomy has been suggested by a number of French and American surgeons, notably Leriche,[21] Simon and Filhoulaud,[22] Soupault and Orsoni,[23] Forster and Wiederkehr,[24] and Veal and Klepser.[25] I am unable to see how any possible improvement can result from such procedures during the acute stage. Absence of sweating proves that the terminal vasoconstrictor fibers are already interrupted, and the local hyperemia is more intense than that produced by sympathectomy. Indeed, the suggestions of Lewis and Love[26] and of Lake[8] that steps should be taken to constrict the main arteries seem more rational. As Greene[5] has stated, "it is to be hoped that without careful previous animal experiments no surgeons will be tempted to follow in the footsteps of these French colleagues." To see if the pain of immersion foot could be relieved by interruption of the sympathetic vasoconstrictors, I blocked the lumbar ganglions with procaine in Case 10. The patient's pain was not influenced in any way, but as I am not convinced that the sympathetic pathways were entirely interrupted, the test should be repeated. On the other hand, procaine injection of the posterior tibial and the superficial and deep peroneal nerves above the angle in the same patient abolished the pain completely.

The only case where lumbar sympathectomy is likely to be of value is in the late stages when the circulation of the foot remains insufficient. Four of the Halifax patients after recovery had unusually cold and sweaty hands as well as feet—a mild variety of Raynaud's disease. One of these (Case 19) who had had a Syme's amputation, continued to be incapacitated by ulceration at the end of the stump. He was tested by procaine block of the vasoconstrictor fibers (both by lumbar paravertebral and by subarachnoid spinal block), but showed no appreciable rise in cutaneous temperature in the ulcerated area. This was evidently due to organic narrowing of the peripheral vessels, secondary to his unusually

prolonged chilling and septic gangrene. Nevertheless, cases will undoubtedly occur, as has already been observed in frostbite, where an inadequate circulation in the late stages of severe immersion foot (with secondary arterial occlusion) can be benefited by lumbar sympathetic ganglionectomy. A number of such patients, who six months after their initial exposure are still suffering from cold and pain in their feet, are under investigation at the United States Naval Hospital in Chelsea at the present moment. In addition to the inadequate circulation of their feet, the presence of increased sweating and of vasomotor changes in their hands indicate that they have an underlying vasomotor syndrome. Although it is unlikely that this condition originated with the exposure, it was probably increased by the psychic trauma.[27] Permanent vasodilatation may well result in secondary relief of the deep plantar pain.

Prognosis

Although it is too early to give accurate statistics of the end-results in immersion foot, it appears that the majority of patients respond favorably to the methods of treatment described above and should be able to return to duty within a month or six weeks. In the rare cases where gangrene develops or there is pre-existent peripheral vascular disease, and particularly when the sufferer has the misfortune to develop a psychoneurosis, convalescence may be protracted.

Summary and Conclusions

Immersion foot, secondary to exposure to cold, appears to be caused by sublethal injury to the chilled tissue cells, the cutaneous arteriolar and capillary bed and the nerve fibers. The process differs only in the degree of chilling and wetting from frostbite, trench foot and shelter foot.

The ischemia during prolonged exposure to intense cold is followed by a period of acute inflammation. The hyperemic reaction of the feet is due mainly to the chemical effects of the products of

tissue injury. Paralysis of the vasoconstrictor fibers is an added factor, but is of secondary importance.

In spite of the increased flow of blood in the main vessels, there is a disparity between the blood-oxygen supply and demand in the cutaneous capillary bed. Capillary permeability is thereby increased. Edema, pain and petechial hemorrhages, as well as the congestion seen when the feet are in the dependent position, are evidence of injury to the blood vessels. By cooling and reducing the local metabolism and need for oxygen, both edema and pain are diminished.

The inflammatory reaction and hyperemia fade in a few weeks, and the circulation usually returns to normal at this time.

Neuritic pain makes its appearance with partial recovery of the nerves and continues until nerve function is restored. It has disappeared within two weeks in some of the mild cases seen in Halifax, but it is impossible as yet to tell how long it may last in the severe ones. In some of the survivors observed in Scotland and in this series, it was troublesome for nearly six months.

Much can be accomplished by suitable treatment. This must be directed primarily at reducing local tissue metabolism in the early period and in preventing further injury and infection of the insensitive swollen feet. Gangrene should be a rare complication.

The rationale and methods of treatment developed so far as outlined, with suggestions for future investigation.

Not all cases of swollen painful feet seen in shipwrecked survivors are due to immersion in cold water. Cases in which this condition has developed in a tropical climate will be discussed in the second part of this paper.

II. PAINFUL SWOLLEN FEET SECONDARY TO PROLONGED DEHYDRATION AND MALNUTRITION

The true immersion-foot syndrome described in the first part of this paper[28] is caused by direct thermal injury to the tissues short of actual freezing. It develops after relatively brief periods of contact with water at temperatures below 50 or possibly even 60° F. A superficially similar, but fundamentally quite different, condition has developed after exposure to warm water and bright sunshine in survivors of torpedoed vessels who have been adrift in the Gulf Stream without an adequate supply of water and food for periods of over two weeks. These individuals may show no evidence of direct cutaneous injury, but yet complain of an equal degree of edema and sensory disturbance. This condition has also been called "immersion foot," but the term is inappropriate in this connection and should be given up.

The cases on which this report is based were seen in a United States Marine Hospital, through the courtesy of Captain W. S. Bean, the commanding officer, a member of the United States Public Health Service. He and his staff have permitted me to add the results of their clinical findings to my own, as well as to make use of their laboratory determinations. The deductions drawn from these data are my own and do not necessarily represent the views of the United States Public Health Service. These survivors of two lifeboat crews have already been the subject of a more detailed report for the Medical Corps of the United States Navy,[29] which will be briefly summarized here in order to point out that there are two fundamentally different conditions that may lead to much pain and incapacity following the sinking of ships at sea in the present war. Since the more complete report was written, new clinical and laboratory data have been furnished me by Drs. Richard H.

Smith and Leo Waitzkin of the United States Public Health Service. This has necessitated a number of minor changes in the evidence presented and in the conclusions to be drawn therefrom.

It should be emphasized at the outset that the syndrome reported here is different in many respects from that observed after immersion in cold water.[28] With these southern survivors, both vessels were torpedoed in relatively warm water (around 70° F.) in southern latitudes during the month of April. The men were adrift for sixteen and seventeen days respectively. Owing to the fact that their ships were torpedoed well off the usual trans-Atlantic shipping lanes and they could not hope for early rescue, their allowance of water was progressively reduced from 16 ounces to a bare 5 ounces a day. With the intense sunshine and heat by day, coupled with the hard work of bailing and handling the boats, both crews developed such severe dehydration that they were unable to swallow the concentrated solid ration of pemmican, hardtack and chocolate. After the first few days all that the men were able to swallow was a small amount of malted-milk powder dissolved in their half-cup of water. Three out of six West African Negroes in the crew of lifeboat A drank salt water and died. All the crew members of lifeboat B survived. The men in both boats were so crowded that they were forced to sit close together with their legs dependent and to sleep in this position. After a week adrift under these circumstances nearly all the men noticed that their feet were become greatly swollen and numb; in addition they began to have a peculiar tingling and aching sensation in the soles. Some noticed similar symptoms in their hands but of lesser degree. The swelling and sensory disturbances in the legs were distinctly less noticeable in the men who had been able to move about the most. A few who took turns as steersman were able to stretch their legs out horizontally during their watches; others realized that the circulation

in their fet was improved and the swelling was lessened by flexing and extending their feet and toes. A number of the men in lifeboat B who went over the side on several occasions to swim alongside commented on the improvement in the condition of their lower extremities. On finally being rescued, all were deeply tanned, and many had developed cracks and small crusted lesions due to exposure to wind and salt water. When they came aboard the rescuing vessels most of the men found that walking on their swollen feet was difficult, and that without support they lost their balance because of numbness in their feet and loss of sense of position. In addition the majority complained of deep plantar tenderness and pain. These exact complaints are also common in sailors rescued after immersion in cold water.[28] On their arrival at the hospital, all the men were suffering from exhaustion, malnutrition and dehydration.

The crew of lifeboat A had wet feet throughout the entire voyage, as their boat leaked continuously. During the last two days, when they sailed out of the warm water of the Gulf Stream and approached the coast, the temperature of the sea water fell to around 50° F. (below the critical level at which thermal injury can occur). As a result of this exposure several of the men, notably the West African Negroes (Cases 6, 7 and 8), ran a low-grade fever (99 to 101° F.) for several weeks* after rescue and developed changes in their feet characteristic of exposure to cold. These consisted of patches of superficial gangrene, blebs and sluggish circulation in the cutaneous capillary bed, with a subsequent hyperemic phase after rescue. This condition, however, was pronounced only in the Negroes and was much milder than that generally seen

*In the case of uncomplicated thermal injury to the feet from cold, the febrile reaction usually subsides within thirty-six hours.[28]

after exposure in northern waters.[28] The crew of lifeboat B were exposed to cool air and suffered from cloudy, heavy weather the first five days, so that their clothes were continuously wet. The weather then cleared and by day "the heat became almost unbearable. . . . Relief was obtained by going overside and swimming. Feet were also soaked in buckets of water. . . . Feet were kept dry except when soaked in buckets during heat of day." The crew of this lifeboat were therefore never exposed to water below 70° F. and showed no signs of cutaneous injury from cold.

After examining these men it was at once apparent that their condition differed fundamentally from that of the survivors seen after rescue from the colder waters of the North Atlantic. Although both groups suffered from swollen and painful feet, many of these survivors of shipwreck in relatively warm water did not bear evidence of tissue damage in their feet, and they had other systemic disturbances of a very different nature. These consisted of slight but definite swelling and subjective sensory disturbances in the hands, as well as the more obvious changes in the feet; many of the men were also found to have glossitis and stomatitis, and additional gastrointestinal complaints. The clinical findings observed in the entire series are summarized in Table 1, and the laboratory determinations in Table 2.

As pointed out above, some direct tissue injury from cold undoubtedly occurred in the crew of lifeboat A during the last two days of their voyage, when they left the warm waters of the Gulf Stream. This was definitely not the case in the men of lifeboat B. But with them, and to a large extent with the men of lifeboat A as well, it is evident that other reasons must have accounted for the greater part of the swelling, which often extended to the

TABLE 1. *Clinical Data on Southern Survivors*

Case No.	Age yr.	Extent of Edema	Cutaneous Changes	Reflexes Knee Jerk	Reflexes Ankle Jerk	Sensory Changes	Muscle Tenderness	Pain	Stomatitis	Day of Discharge	Comment
CREW OF LIFEBOAT A											
1	29	++	Superficial gangrene in toe 5 (R); superficial desquamation in toes 1, 3, 4 and 5 (L).	+	+	Hypesthesia and tingling in distal half of feet	+	0	+++		Patient had marked degree of malnutrition and diarrhea for a month preceding torpedoing. In lifeboat he cowered on floor boards without moving. His general condition was precarious at first; he was semistuporous and had diarrhea with occult blood. Thermal injury to the feet was definite.
2	26	+	0			0	0	0	0	29th	Patient exercised feet during period of dependency.
3	22	±	Several small areas of cornification and desquamation	++	+	Skin of feet and lower legs hypersensitive	0	0	+	31st	Patient exercised feet while in lifeboat, and evidence of thermal injury was not marked. Neuritis disappeared within a week, but he developed a severe stomatitis 3 days after rescue, with fever and leukocytosis. This disappeared within a week after treatment with vitamin B.
4	32	0 (formerly present)	0	+	+	Numbness at first when walking; hypesthesia wore off distally, disappearing in 3 weeks	0	++	0	29th	Patient exercised feet while in lifeboat. Neuritis gone in a week.
5	35	+	0			Hypesthesia receded to toes in 3 weeks	0	0		29th	
6 Negro	23	++	Deep cracks and blebs in skin of soles, with eventual sloughing			Impossible to evaluate owing to language difficulties	+	+++	0		Pain developed in 5 days. On admission, a sterile inflammatory reaction, the characteristic response of tissues after immersion in cold water, was pronounced. Patient had fever to 101° F. for 9 days. Feet became painless after 7 weeks, without vitamin therapy.
7 Negro	57	+++	Desquamation and epidermophytosis; hands also swollen at first.	+	+	Pain and sensory changes in hands for 2 weeks; hypesthesia distal half of feet present after 3 weeks	+	++	0		Patient's bare feet in water most of the time. Pain started after 3 days. On rescue, edema extended to knees. Reactive hyperemia was marked. Patient had fever to 100.5° F. for 3 weeks. Edema subsided promptly with treatment in Pavaex boot, but pain persisted for over 7 weeks. Thermal injuries were definite and probably cause of neuritis. Vitamin therapy was ineffective.

TABLE 1. *Clinical Data on Southern Survivors.**
(Continued)

Case No.	Age yr.	Extent of Edema	Cutaneous Changes	Reflexes Knee Jerk	Reflexes Ankle Jerk	Sensory Changes	Muscle Tenderness	Pain	Stomatitis	Day of Discharge	Comment
8 Negro	39	+	0	+	+	Hypesthesia at first to ankles, receding to toes in 3 weeks	0	++			Edema extended to knees, with sterile inflammation of feet. Temperature rose to 100° F., lasting a fortnight. Burning pain in feet persisted for a month. No vitamin therapy given. Thermal injury was less marked than in Cases 6 and 7.
CREW OF LIFEBOAT B											
9	33	0	0			0	0	±	+++	14th	Patient exhausted and in poor general condition.
10	44	0	0			Hypesthesia of toes; subjective changes in hands	+	++	0	14th	Patient exhausted but made good recovery.
11	50	R: ++ L: +	0			Hypesthesia and paresthesia; subjective changes in hands	+	+	+	11th	Neuritis disappeared in 3 days.
12	35	0	Superficial crusted lesions due to sun and windburn			Sensation objectively normal but subjectively abnormal in hands as well as feet	+	+	+	11th	Sensory disturbances disappeared before discharge.
13	24	±	0			Sensation objectively normal but subjectively abnormal in hands as well as feet	+	+	+	11th	
14	32	0	0			Distal half of feet hypesthetic; hands to lesser degree	+	+	0	11th	Neuritis disappeared in 3 days.
15	25	0	0			Subjectively both hands and feet feel abnormal	+	++	0	11th	Neuritis cleared quickly.

*Crew of lifeboat A examined 3 weeks after rescue; those of lifeboat B, 2 days after rescue.

TABLE 2. *Available Laboratory Data on Southern Survivors.**

CASE NO.	DATE	SPECIFIC GRAVITY OF URINE	BLOOD										OCCULT BLOOD IN FECES
			RED-CELL COUNT $\times 10^6$	HEMOGLOBIN *gm.*	WHITE-CELL COUNT $\times 10^3$	TOTAL PROTEIN *gm./100 cc.*	ALBUMIN *gm./100 cc.*	GLOBULIN *gm./100 cc.*	UREA NITROGEN *mg./100 cc.*	CHLORIDE *mg./100 cc.*	ASCORBIC ACID *mg./100 cc.*	PROTHROMBIN TIME *sec.*	
1	4/15/42	1.025	—	—	—	—	—	—	—	—	—	—	—
	4/16/42	—	4.00	15.3	12.3	5.4	3.5	1.9	24.0	—	—	—	+
	4/20/42	1.019	3.81	13.3	10.9	3.3	1.7	1.6	—	—	—	—	—
	4/27/42	1.018	—	—	—	4.8	2.8	2.0	—	—	—	—	—
	5/7/42	—	—	—	—	5.4	3.3	2.1	—	—	—	—	—
2	4/15/42	1.030	—	—	—	—	—	—	—	—	—	—	—
	4/17/42	—	5.58	13.7	8.7	—	—	—	—	—	—	—	—
3	4/15/42	1.018	—	—	—	—	—	—	—	—	—	—	—
	4/17/42	—	5.89	13.3	15.1	—	—	—	—	—	—	—	—
4	4/15/42	1.025	—	—	—	—	—	—	—	—	—	—	—
	4/17/42	—	4.63	16.4	5.4	—	—	—	—	—	—	—	—
5	4/15/42	1.025	—	—	—	—	—	—	—	—	—	—	—
	4/17/42	—	5.09	14.0	9.6	—	—	—	—	—	—	—	—
6	4/17/42	—	3.63	10.5	13.9	—	—	—	—	—	—	—	—
	4/24/42	—	4.35	11.0	8.3	—	—	—	—	—	—	—	—
7	4/15/42	1.025	—	—	—	—	—	—	—	—	—	—	—
	4/17/42	—	4.99	13.3	10.0	—	—	—	—	—	—	—	—
	4/18/42	—	—	—	—	5.1	2.4	2.7	13.3	770	—	—	—
8	4/15/42	1.020	—	—	—	—	—	—	—	—	—	—	—
	4/17/42	—	4.06	12.9	6.9	—	—	—	—	—	—	—	—
9	5/8/42	—	—	—	—	6.0	—	—	—	410	1.98	27	0
10	5/8/42	1.012	4.68	12.4	15.6	—	—	—	—	390	1.82	25	—
	5/9/42	—	—	—	—	5.6	—	—	—	—	—	—	+
	5/13/42	—	5.05	12.1	6.9	—	—	—	—	—	—	—	0
11	5/8/42	1.023	—	—	—	—	—	—	—	—	—	—	—
	5/9/42	—	—	—	—	—	—	—	—	—	—	—	+
	5/14/42	—	—	—	—	—	—	—	—	—	—	—	0
12	5/8/42	1.014	—	—	—	—	—	—	—	—	—	—	+
13	5/8/42	1.023	—	—	—	—	—	—	—	—	—	—	0
14	5/8/42	1.025	—	—	—	—	—	—	—	—	—	—	+
15	5/8/42	1.029	—	—	—	—	—	—	—	—	—	—	+
16†	—	—	—	—	—	—	—	—	—	—	—	40	—

*The figures do not show the striking alterations in the blood and urine which go with severe dehydration, but it must be remembered that these men had already had up to twenty-four hours to restore their depleted body water reserves before any of the above determinations could be made. Other compensatory factors must also be taken into account. Although Cases 2 and 3 show a definite erythrocyte concentration, the anemia that goes with starvation would counterbalance this. All the serum protein levels are low, and would have gone lower, as was so in Case 1, if further estimations had been made after the water balance had returned to normal levels. Half the patients still had a urinary specific gravity of 1.025 or higher after nearly a day's unlimited access to water. The blood urea nitrogen level of 24 mg. in Case 1 is distinctly elevated and the figure of 13.3 mg. in Case 7 is not significant, as it was not obtained until three days after rescue. Loss of blood electrolytes was pronounced in Cases 9 and 10. This was presumably caused by excessive sweating with a low salt intake, whereas the patient in Case 7, who had drunk salt water, had a very high level. The ascorbic acid figures in Cases 9 and 10 are not reduced.

†This patient, not included in the study because he had just been operated on for gastric hemorrhage, had the highest prothrombin time observed.

knees,† as well as the tenderness and other sensory changes, which involved the feet and, in some cases, the hands as well. Other contributory factors which might account for these findings are the following:

(1) *Continued dependency of the legs.* Hypostatic edema is always a factor after a voyage in a crowded lifeboat of prolonged duration when there is no space to stretch the legs out horizontally and men are forced to sleep in a sitting position.

(2) *Hypoproteinemia.* As a result of extreme dehydration, these men had been unable to swallow any solid food after the first few days adrift. In addition, they were forced to row and bail, the energy for which had to be provided from their own tissues. As a result it is not surprising that many were found to have a serum protein below the critical level at which edema develops. The low albumin-globulin ratio in Cases 1 and 7 is of particular significance. From the experimental work of Jones, Eaton and White[30] on nutritional edema in animals, it is probable that the swelling in the legs of these men was far less marked during the period that they were adrift and critically dehydrated, and that it developed rapidly as they were able to restore their depleted tissue fluids. There was also a progressive fall in serum protein in the course of rehydration, which is well exemplified by the serial determinations made in Case 1.

(3) *Vitamin deficiency.* One is led to speculate whether the intense aching pain and deep plantar tenderness complained of by these survivors during the last week at sea and in the hospital could be caused solely by edema secondary to dependency and hypoproteinemia. It appears most unlikely that this could have been the case, and it is not possible to explain hypesthesia and ataxia of the feet, and similar subjective disturbances of the hands, on this basis. This picture is more suggestive of a deficiency in the antineuritic factor in the vitamin B complex, such as is seen in alcoholic neuritis. Examination of the knee jerks in these subjects showed normal responses in the 4 patients tested. This is incompatible with the advanced type of neuritis due to long-standing avitaminosis, but in no way rules out the earlier stages, which might occur in such a relatively brief period.

†The changes due to cold water generally involve only the feet and lower third of the legs.[28]

Further clinical findings that suggest an avitaminosis were the oral lesions. Of the patients examined, Cases 1, 3, 9, 11, 12 and 13 reached the hospital with a nonspecific stomatitis. This consisted of superficial vesicles and ulcers of the tongue, buccal mucosa, palate and pharynx. In Cases 1, 9 and 12 the sides of the tongue were smooth and reddened, and the patient in Case 13 had suffered from bleeding gums. It is also of interest to note that in 7 out of 9 patients where the feces were examined with the guaiac and benzidine reagents, the tests were at first positive for occult blood (Cases 1, 10, 11, 12, 14, 15 and 16). It is of further interest that in the 3 patients in whom the prothrombin times were determined, there was an increase beyond the normal period of 20 seconds to 40, 27 and 25 seconds, although there is some question concerning the accuracy of these figures. If the values are correct, they denote a definite deficiency in vitamin K, which reached a severe degree in Case 16. This man, who had a history of chronic indigestion, became severely exsanguinated from a bleeding gastric ulcer, which finally necessitated surgical intervention. Another survivor in the same hospital, who had been rescued after a long period adrift in warm water, also suffered exsanguinating gastric hemorrhages, from which he died. It is possible that this bleeding from the gastrointestinal tract, as well as the stomatitis, is related to nicotinic acid deficiency, since ulcerations may occur at any level in the gastrointestinal tract in the deficiency state. Further studies on the role of vitamin deficiency in shipwreck survivors are urgently needed before any definite conclusions can be drawn.

Heretofore, the signs of alcoholic neuritis and pellagra have not been known to occur in as brief a period as a fortnight. In fasting subjects who have been studied for longer periods, sensory changes in the extremities have not been recorded, but these observations have been made on inactive persons. The fact that thiamin, nicotinic acid and riboflavin play an active chemical role in the oxidation of glucose may explain their rapid depletion in these survivors. A depletion of the antineuritic and other components of the vitamin B complex is, therefore, a distinct possibility. It is also possible

that the men who suffered the most were in a partially depleted state before their ships were torpedoed and their vitamin intake stopped. This was certainly true in Case 1, but I was unable to discover any evidence of this in the other men.

In order to obtain further information concerning the possibility that vitamin deficiencies arise in such a short period of time, I consulted two authorities on vitamin deficiency, Dr. John B. Youmans, associate professor of medicine at Vanderbilt University School of Medicine, and Dr. W. H. Sebrell, chief of the Division of Chemotherapy of the United States Public Health Service. Dr. Youmans wrote:

> Patients with nutritional edema very frequently develop pain and tenderness, and sometimes superficial inflammation (erythema), particularly when the onset is rather abrupt. . . . With a very restricted diet and with hard work, some deficiencies such as that due to vitamin B_1 are believed to develop evidence of the deficiency within a week or so. . . . The stomatitis and glossitis may well represent a combination of a deficiency of the vitamin B complex, including riboflavin plus dehydration. Dehydration is quite important as there is evidence that this precipitates the syndrome of pellagra.

Dr. Sebrell, who subsequently saw some of this group of patients, states that his "impression is that thiamin and nicotinic acid deficiencies are definite possibilities." When further similar cases can be located he is prepared to make special tests to give accurate information about the thiamin and nicotinic acid levels. Examination of the scleras by the slit-lamp for peripheral vascularization and of the lips and mouth by experts in riboflavin and nicotinic acid deficiency will answer this question with certainty.

Unlike the more severe thermal injuries suffered by the survivors of vessels torpedoed in the North Atlantic, where vascular thrombosis and sepsis may necessitate amputation, the peripheral lesions of the cases from southern waters were not serious and required over a fortnight's hospitalization in only 6 cases. Three of these were the West African Negroes who undoubtedly had complicating injuries from immersion in cold water and less evidence of a vitamin deficiency than their Anglo-Saxon crew mates. The possible increased sensitivity of the West African Negroes to cold and their

greater resistance to dietary deficiency will be a point of interest for further investigation. In examining the northern survivors I had been impressed by the fact that the reaction caused by immersion in cold water rarely extended much above the ankles, whereas in these cases it rose nearly to the knees. The edema subsided promptly on bed rest, elevation of the legs and an adequate diet. The most incapacitating symptom was the neuritic pain in the feet. These persisted for nearly two months in the 3 Negroes, 2 of whom were not given special vitamin therapy. Whether due to specific action or merely coincidentally, the neuritic manifestations disappeared within a period of three to ten days in the other men after a high intake of vitamin B.

In evaluating these survivors of exposure, malnutrition and dehydration, it seems reasonable to conclude that the men of lifeboat A suffered injury from cold of slight but definite degree. This, however, falls far short of explaining the entire clinical picture that they presented. Although the crew members of lifeboat B were generally chilled by the cloudy, heavy weather of the first five days, thereafter they suffered from intense heat and their feet remained dry except when they wet them for relief. Their most striking symptoms — edema to the knees sensory disturbances, which in some cases involved the hands as well as the feet, stomatitis and ulceration of the gastrointestinal tract — must be accounted for on a basis other than immersion in cold water. These conditions made their appearance slowly, the first tingling and pain developing at the end of a week. The edema can be readily explained by the prolonged dependency and protein deficiency. Whether the sensory disturbances and ulceration of the mucous membranes of the digestive tract are wholly or merely in part due to vitamin deficiency must require final proof from future more complete studies. Opportunities for such studies are now frequently present, particularly in the war in the South Pacific.

In the matter of treatment, much can be accomplished prophylactically by furnishing a more suitable lifeboat ration for vessels on tropical voyages. One of the hard facts brought out by the present

naval war is that dry, concentrated foods are worse than none at all when water is scarce. Although the problem of supplying a more satisfactory ration remains to be worked out, an adequate intake of the various components of the vitamin B complex can be supplied very simply and inexpensively by tablets of brewer's yeast.* The protective properties of fresh meat are well known, and whenever this can be obtained in the form of birds, fish or shellfish, the raw meat, blood, liver and other viscera can, with few exceptions,[31] be consumed with safety. It is of interest in this connection that Captain Bligh's company, in the famous voyage from Tofoa to Timor after they were cast adrift by the mutineers on the *Bounty,* did not develop any symptoms of neuritis after six weeks on starvation rations supplemented by small quantities of fish, mussels and eggs of sea birds.[32] Judging from the experience of Dixon, Pastula and Aldrich, [33] who navigated the South Pacific for thirty-four days in a small rubber raft, an adequate diet can be obtained in many parts of the tropical seas if the lifeboat or raft is equipped with a small-caliber shotgun of rustless steel and a hand line or two. Richards and Banigan,[31] the authors of a very practical manual on how to abandon ship, point out that a fish spear is more useful than a hook and line—"Your hook either will be taken by a large fish, which will snap your line, or a small fish, which will be devoured before you can draw it in."

The skin can be protected against salt-water blisters in the tropics and also against cold by greasing,[28] therefore a liberal supply of heavy oil should be included in all lifeboat stores. In intense sunshine the skin must also be protected by some form of clothing and, if possible, by rigging an awning over the boat. Any constricting clothing about the legs or tight shoes should be removed. In addition to greasing the feet, stretching the legs horizontally and forcibly flexing and extending the toes are of great value in reducing edema and stiffness of the muscles. Weather and absence of sharks and

*More concentrated preparations are available that contain reasonable proportions of the various components in the vitamin B complex. Among these are Unicaps (Upjohn) and Vitamin B Complex Capsules (Lederle).

barracuda permitting, getting into the water and paddling alongside the boat has been found extremely helpful by all the sailors who have tried it. This not only prevents loss of water by sweating, but the muscular movements in a horizontal position increase the flow of lymph and return a considerable quantity of edema fluid to the circulation.[34]

When survivors are picked up they should be lifted on board the rescuing vessel and carried below to prevent further damage to the skin of their insensitive, swollen feet. If there is injury to the skin from sun and salt-water burns, prevention of sepsis is important. This and the care of cold-water injuries have been described in the first part of this paper.[28] Further local treatment should include elevation of the swollen legs, Buerger's postural exercises and physiotherapy, if carried out in a hospital by an experienced person.

The most urgent need of these survivors at the time of rescue is the proper treatment of their dehydration and malnutrition. This treatment is carried out along standard lines and will not be discussed here. In addition to a high protein intake, such patients should be given a therapeutic test of vitamin B in large amounts, with daily intramuscular injections of thiamin chloride, 50 mg., and Lederle's vitamin B complex, 10 cc. (this contains thiamin, nicotinic acid and riboflavin). If the response is favorable, it will go far to establish the diagnosis of vitamin B deficiency. Once this point has been settled, a less expensive therapy consisting of brewer's yeast (which contains large amounts of all the vitamin B components) and a diet of green vegetables, carrots, butter and liver can be substituted.

Summary and Conclusions

The painful swelling of the feet observed in two lifeboat crews, adrift for prolonged periods in the Gulf Stream, had fundamental clinical and etiologic differences from the "immersion-foot" syndrome which so often develops in the survivors of vessels lost in the colder waters of the North Atlantic.

Both groups of men had edema of the feet due to prolonged dependency and immobility.

In the case of the men torpedoed in the North Atlantic, additional swelling and neuritic pain were caused by direct injury to the skin, cutaneous capillaries and nerves by immersion in cold water.

Immersion in warm water per se cannot account for either edema or pain in the legs and feet. Therefore the syndrome reported here should not be classified as immersion foot.

In most of the men who were adrift for long periods in southern latitudes, direct thermal injury can be excluded (at least in the crew of lifeboat B). Hypoproteinemia from starvation was an additional cause of swelling in these survivors. Edema of this type is not generally considered to be painful. It is postulated, but not proved, that the stomatitis, sensory disturbances in the hands and feet, and plantar tenderness that developed in these patients were caused by a deficiency of the antineuritic factor and other components in the vitamin B complex. Evidence is quoted to show that such a deficiency may occur at a greatly accelerated rate in the rapid tissue-oxidation reactions that take place in men who are forced to do hard physical work in a hot climate on a very inadequate fluid intake.

An added deficiency in vitamin K was suspected in 3 cases in which the prothrombin times were determined, and loss of blood in the stools was a common occurrence.

The possibility that a deficiency of vitamins B and K may develop as a complication of shipwreck in such a brief period as two and a half weeks has not heretofore been suggested.

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